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SIXTH ANNUAL REPORT

OF THE

LOCAL GOVERNMENT BOARD

1876–77.

SUPPLEMENT

CONTAINING

REPORT OF THE MEDICAL OFFICER

FOR 1876.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.
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FOR THE YEAR

1876.

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REPORT.

To the Right Honourable George Sclater-Booth, M.P.
President of the Local Government Board.

Sir,

Medical Officer's Report.

I have the honour to lay before you my report of the special work done through the Medical Department of the Board in matters concerning the Public Health in the year 1876: this work having, during the first five months of the year, been under the direction of the late Medical Officer of the Board, Mr. Simon, and during the remainder of the year under my own direction.

Though the statutable office of "Medical Officer of the Privy Council and Local Government Board" ceased on the resignation of Mr. Simón (no provision for its continuance having been made in the Statute which constituted the Local Government Board, and transferred to them the powers and duties in relation to Public Health theretofore exercised by the Privy Council), the powers of appointment which the Local Government Board themselves possessed were ample for the constitution of an analogous office, and for the appointment of an officer who, as Medical Officer to the Board, should in fact execute all the duties of that office. Accordingly, under the office which I have the honour to hold, those duties are all provided for: and the present Report is the first of a series which, under an altered title and a different form of presentation to Parliament, is intended to be a continuation of that remarkable series of reports which, begun by Mr. Simon in 1859 and continued by him annually (with a slight interruption) till 1875, has had so large an effect in shaping professional and public opinion in sanitary matters in England and abroad. I am deeply sensible of the disadvantage at which I stand in being called upon to follow Mr. Simon in the continuance of this great work; and the chief hope I have of being able to do this, with even the most moderate degree of success, is derived from the close and intimate association with him I have enjoyed for nearly 20 years in every matter having relation to the Public Health.

It being your wish that all matters of general business in which my Department takes part should be in future included in the Board's General Report, and that my own Report should deal with special matters exclusively, I have no observations to make here on the subject of public vaccination. This is fully treated of in the Board's present Report. But as the subject is one of great interest to my profession, into whose hands this volume is chiefly likely to fall, and by whom generally the Board's Report is probably little consulted, I am happy in having your permission to reprint from the General Report the tables relating to it. They form Nos. 1–3 of my Appendix.

I. The local inquiries made in 1876 by the inspectors of the Department into particular outbreaks of disease, or as to local conditions giving rise to constant prevalences or unusually frequent recurrences of certain diseases, have amounted to 19, sanction having been given by you for the institution of many more such inquiries had the inspecting force of the Department enabled them to be undertaken. The revelations made from quarter to quarter by the Registrar General of high death-rates from enteric fever, scarlet fever, diarrhœa, diphtheria, and other diseases generally classed as preventable, have been the chief occasions of these inspections, an abstract of the chief circumstances of which, as well as of two inquiries of a special character, made by Mr. Netten Radcliffe, into outbreaks of erysipelas, will be found in Appendix 4. Several of the inspections embraced the area of two or more sanitary authorities, and the 19 inspections have given rise to communications with 27 such authorities. In some of the places inspected prevalence existed of more than one infectious disease,—as at Calstock, where typhoid fever is stated by the inspector to be endemic and diphtheria of annual occurrence; at Great Coggeshall, where also there was serious prevalence of both those diseases; and in the Redruth Registration District, in which scarlet fever, enteric fever, diarrhœa, and diphtheria were all met with. In some cases the defective sanitary state of the places visited was manifested by other signs besides the prevalence of diseases of the above class, *e.g.*, by the high rate of infantile mortality found to prevail at Portsmouth and in the Redruth District, or the amount of phthisis in the Pontypridd district. On the whole, with reservation as to two outbreaks of diphtheria, the origin of which was difficult of ascertainment, the result of the inspections was to show, in all the districts inspected, not only their defective sanitary state, but also the very imperfect action of the sanitary authority. In many of these inspections the want of proper hospital accommodation for the isolation of cases, and especially of the earlier cases, of infectious disease, was found to have been a serious obstacle to the limitation of the spread of such diseases. For a long time past the Board have been strenuously urging on local authorities the provision of such hospitals.

Among the sanitary inspections made in 1876 was one, undertaken under peculiar circumstances, into the prevalence of erysipelas and other traumatic infections in the wards of the Manchester Royal Infirmary, the report on which, by Mr. Radcliffe, is of particular interest. Taken along with a Report which Mr. Radcliffe had made the preceding year into an analogous state of things in the Norfolk and Norwich Hospital, and with a Report (which he has most kindly placed at my disposal) of an inquiry which he had unofficially made during a period of vacation in 1874 into the state of the Radcliffe Infirmary, Oxford, at the request of the Managers, a series of papers is constituted which appears to me of so much value in reference to the important subject of Hospital Hygiène that I have thought it desirable to print them in extenso (Appendix 5). They not only illustrate the influence which defects of site and construction, including especially defective arrangements for drainage and ventilation, have in the production and extension of such diseases as Mr. Radcliffe had to report on, but they exhibit the dangers which arise from faulty management, and the necessity for attaching to some officer in every hospital a direct and special responsibility for its daily sanitary supervision.

II. The laborious and extensive inquiry which Dr. Ballard has been for some time pursuing into the effluvium nuisances which arise in connexion with various manufacturing and other branches of industry, and especially with regard to the effect upon health of each such industry, and to the degree in which the nuisance can be prevented, was prosecuted with great activity in 1876, and I am happy in being able to present a first instalment of the results of his labours (Appendix 6). It has been the great aim of Dr. Ballard to establish his practical conclusions on a sufficient basis of observation, and towards that end no pains have been spared by him, as will be evident on a mere glance at the list of places visited and the number of institutions and work places examined, as well as from the full and careful nature of the descriptions given. The present division of his Report treats only of nuisances arising from the keeping of animals, from the slaughtering of animals, and from those branches of industry in which animal substances, or substances of animal origin, are principally dealt with. It will be followed in due time by other divisions, in which will be fully considered the nuisances arising from branches of industry in which vegetable substances, mineral substances, and substances of mixed origin are chiefly concerned.

III. Of foreign epidemics concerning which the Local Government Board were called on in 1876 to give advice through their Medical Department, the only one requiring special mention is the Plague, which disease prevailed in Mesopotamia and extended to some places in Persia in the first half of the year. It subsided as usual in July, but has again, I regret to say, reappeared during the present year. Mr. Simon's report for 1875 contains a most interesting memorandum by Mr. Netten Radcliffe on the modern history of that disease and its recent progress up to the then time of writing; and Mr. Radcliffe now contributes to my present report a further memorandum (Appendix 7), in which he continues his narration to the middle of the present year (1877), and adds, at my request, a synopsis, from official despatches, of the so-called preventive measures adopted by the Ottoman and other Governments. In its bearing on questions of quarantine this account is full of interest.

On this subject of foreign epidemics I must not omit to advert (as possibly ultimately concerning us in this country) to the progress which cholera made in 1876 beyond the boundaries of India into Affghanistan and Beloochistan; an event of the more consequence, as following a very serious extension of the disease in India itself in 1875–6.

IV. With a view to the more systematic examination of the Reports made annually to the Board by the local Medical Officers of Health distributed over the kingdom, it became necessary in 1876 to issue more detailed instructions than had heretofore been given with regard to the preparation of these reports, and for this purpose a circular letter of instructions was drawn up by me and issued by the Board. It became necessary also in 1876 to re-edit some of the official memoranda of the Department, viz., the Precautions against Scarlatina; the memoranda as to local arrangements relating to Infectious Diseases; the memorandum on Re-vaccination; and the memorandum of the National Vaccine Establishment on Lymph-Supply for Re-vaccination. All these documents will be found in my Appendix No. 8.

I have the honour to be,
Sir,
Your obedient Servant,

June 30, 1877.
EDWARD C. SEATON.

APPENDIX.

No. 1.

App. No. 1.

Digest of Vaccination Returns.

Digest of the **Vaccination Officers' Returns** (so far as received to January 31st, 1876) with regard to children whose births were registered in 1874.

The following return, which is the third annual return under the Vaccination Act, 1871, shows the continued successful working of that Act. Of 854,787 births returned to the Board by the several Vaccination Officers in England and Wales as registered during the year 1874* the number which at the time the return was made had been registered as successfully vaccinated was 727,065 (being 85·05 per cent. of the whole), and the number registered as having died before they could be vaccinated was 85,325 (or 9·9 per cent. of the whole). Of the remaining 42,397 children, 920 (or 0·107 per cent. of the whole) had been registered as insusceptible of successful vaccination;† 96 (or 0·01 per cent.) as having contracted small-pox before they could be vaccinated; 5,677 (or 0·66 per cent.) as having their vaccination postponed by medical certificate, leaving 35,704 (or 4·17 per cent.) as "removed," "not to be traced," or otherwise unaccounted for.‡ If from the 854,787 births returned by these officers deduction of the deaths without vaccination be first made, it appears that of the surviving 769,462 children, there were registered at the time of the return 94·49 per cent. as successfully vaccinated; 0·132 per cent. as either insusceptible of vaccination, or as having had small-pox; and 0·73 per cent. as under medical certificate of postponement; leaving 4·6 per cent. as at that time still to account for.

Of the 34,704 registered births entered in the last column of the return as remaining unaccounted for, the very large majority were children who could not be found by the Vaccination Officers, usually because of the removal of the parents from the place of birth, but sometimes because of the birth itself having been registered (as is not uncommon in the case of illegitimate children) under a false name or false address. In many districts the amount of removals without vaccination which was returned was larger and in some considerably larger than it should have been, on account of undue delay on the part of the Vaccination Officer in instituting the inquiries which the Board's "Instructions to Vaccination Officers" direct. The remaining cases in the column (with the exception of a certain number in which vaccination had really been performed successfully, but which could not be registered as vaccinated on account of the legal certificate of vaccination not having been received by the vaccination officer) were cases which at the time of the return remain unvaccinated in the union or district of birth. Local imperfections in administrative machinery, as *e.g.* the employment of an insufficient number of vaccination officers or the employment of persons whose time was taken up too much by other work, want of activity or intelligence in the discharge of their duties on the part of the officers themselves, and want of due supervision of the officers by the guardians, were the main causes of this default, where it occurred. The number of cases in which non-vaccination was due to direct refusal on the part of parents to comply with the law when required to do so, constitutes an utterly insignificant proportion of the cases entered in this column.

---

* No return was received from the Danby district of the Guisborough Union (78 births).

† Of these probably not one was really insusceptible. The cases included under this heading are children, who being certified as having been three times unsuccessfully vaccinated, are no longer subject to the compulsory provisions of the law.

‡ Correspondence in 1876 shows that many of these cases have since been accounted for.

As in the preceding years, the results have been much less complete in the metropolis than in the rest of the kingdom generally; the proportion of registered births in the former which are not finally accounted for in the return being 8·8 per cent., while in the latter it is but 4·17 per cent., and the proportion unaccounted for after deduction of the postponed cases being 7·78 and 3·57 per cent. respectively.

Returns, 1874.

App. No. 1.

Digest of Vaccination Returns

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.	Percentage of Children not finally accounted for, including Cases postponed.
ENGLAND AND WALES.	854,787	727,065	920	96	85,325	5,677	35,704	4·8
Do. excluding Metropolitan Unions.	732,842	627,675	669	88	73,833	4,364	26,213	4·17
METROPOLITAN UNIONS.	121,945	99,390	251	8	11,492	1,313	9,491	8·8
COUNTIES.								
Bedford - -	5,193	4,493	2	—	584	28	86	2·1
Berks - -	7,477	6,649	5	—	572	76	175	3·3
Bucks - -	5,058	4,463	6	—	481	29	79	2·1
Cambridge - -	6,241	5,442	4	—	622	41	132	2·7
Chester - -	20,087	17,397	15	2	2,034	93	546	3·1
Cornwall - -	10,760	9,177	3	—	1,211	116	253	3·4
Cumberland -	8,274	7,264	4	—	802	44	160	2·4
Derby - -	13,362	11,614	16	—	1,414	42	276	2·3
Devon - -	17,898	15,736	19	—	1,493	189	461	3·6
Dorset - -	5,358	4,715	2	—	409	48	184	4·3
Durham - -	38,340	31,790	53	7	4,569	330	1,591	5·0
Essex - -	15,722	14,052	15	—	1,203	68	384	2·8
Gloucester - -	16,304	14,061	12	2	1,484	75	670	4·5
Hereford - -	3,374	2,895	5	—	306	16	152	4·9
Herts - -	7,079	6,354	8	—	587	29	101	1·8
Hunts - -	1,757	1,596	1	—	139	11	10	1·1
Kent (extra metropolitan).	21,200	18,981	20	—	1,608	138	453	2·6
Lancaster - -	121,182	104,187	75	9	12,662	523	3,726	3·5
Leicester - -	10,750	8,965	9	—	1,386	58	332	3·6
Lincoln - -	14,292	11,842	15	6	1,538	178	713	6·2
Middlesex (extra metropolitan).	8,661	7,283	24	—	713	65	576	7·4
Monmouth - -	9,163	7,945	5	1	816	50	346	4·3
Norfolk - -	13,105	11,329	16	—	1,330	85	345	3·2
Northampton -	8,960	7,623	9	—	992	40	296	3·7
Northumberland -	16,032	13,741	7	1	1,809	121	353	2·9
Nottingham -	14,324	11,995	10	—	1,657	107	554	4·6
Oxford - -	5,745	4,793	5	1	578	38	330	6·4
Rutland - -	667	598	1	—	55	4	9	1·9
Shropshire - -	8,372	7,349	10	—	750	33	230	3·1
Somerset - -	14,922	13,058	24	—	1,246	134	460	3·9
Southampton -	16,580	14,636	14	—	1,296	164	470	3·8
Stafford - -	33,438	28,434	22	4	3,449	96	1,433	4·5
Suffolk - -	11,146	9,859	10	—	889	62	326	3·4
Surrey (extra metropolitan).	12,235	10,535	19	1	981	123	576	5·7
Sussex - -	13,291	11,674	17	—	1,040	117	443	4·2
Warwick - -	24,492	20,877	38	34	2,579	50	914	3·9
Westmoreland -	2,118	1,928	—	—	163	7	20	1·2
Wilts - -	7,589	6,793	4	—	619	36	137	2·2
Worcester - -	19,318	16,514	18	5	2,018	91	672	3·9
York, E. R. - -	11,489	9,714	17	—	1,267	54	437	4·2
York, N. R. - -	8,733	7,313	6	2	988	91	333	4·8
York, W. R. - -	77,163	62,591	67	12	9,095	270	5,128	6·9
WALES.								
Anglesey - -	888	725	5	—	88	4	66	7·8
Brecknock - -	1,856	1,612	1	1	188	5	49	2·9
Cardigan - -	2,151	1,857	—	—	194	29	71	4·6
Carmarthen - -	4,287	3,825	1	—	383	28	50	1·8
Carnarvon - -	3,490	3,038	6	—	375	35	36	2·0
Denbigh - -	2,829	2,468	—	—	262	24	75	3·5
Flint - - -	2,950	2,637	1	—	248	14	50	2·1
Glamorgan - -	19,605	16,835	18	—	1,961	117	674	4·0
Merioneth - -	2,101	1,820	—	—	226	27	28	2·6
Montgomery -	2,380	2,044	3	—	188	54	91	6·0
Pembroke - -	2,432	2,100	2	—	238	56	36	3·7
Radnor - -	623	459	—	—	48	1	115	13·6

Unions.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.	Percentage of children not finally accounted for, including Cases postponed.
METROPOLITAN UNIONS.								
Bethnal Green - -	5,183	4,090	3	—	590	28	472	9·6
Camberwell - -	4,588	3,651	15	—	445	62	415	10·4
Chelsea - - -	2,440	2,009	5	—	271	6	149	6·3
Fulham - - -	2,836	2,369	10	—	277	21	159	6·3
George's, St. - -	4,303	3,592	21	1	400	—	289	6·7
George St., East - -	1,830	1,372	—	—	197	15	246	14·2
Giles and George, SS. -	1,708	1,316	5	—	177	8	202	12·2
Greenwich - -	4,049	3,522	9	—	322	88	108	4·8
Hackney - - -	4,772	3,568	10	1	394	57	742	16·7
Hampstead - -	824	684	2	—	58	10	70	9·7
Holborn - - -	6,207	4,942	4	—	611	1	649	10·4
Islington - -	8,711	7,371	13	—	717	48	562	7·0
Kensington - -	4,364	3,589	18	—	444	51	262	7·1
Lambeth - - -	8,498	6,734	28	2	832	40	862	10·6
Lewisham - - -	1,781	1,599	7	—	139	4	32	2·0
London, City - -	1,614	1,340	4	—	161	39	70	6·7
Mary-le-bone - -	5,046	3,874	8	—	581	106	477	11·5
Mile End Old Town -	3,901	3,139	3	—	325	73	361	11·1
Olave, St. - - -	5,330	4,614	9	1	435	86	185	5·0
Paddington - -	2,943	2,416	14	—	225	52	236	9·7
Pancras, St. - -	8,042	6,728	17	—	693	7	597	7·5
Poplar - - -	5,409	4,488	6	1	591	43	280	5·9
Saviour, St. - -	7,210	5,622	8	—	796	153	631	10·8
Shoreditch - -	5,210	4,051	9	—	473	178	499	12·9
Stepney - - -	2,074	1,622	1	—	218	9	224	11·2
Strand - - -	981	773	1	—	107	17	83	10·1
Wandsworth and Clapham	5,251	4,514	15	1	490	38	193	4·3
Westminster - -	1,362	1,198	—	1	106	9	48	4·1
Whitechapel - -	2,686	2,161	1	—	207	48	269	11·8
Woolwich - -	2,792	2,442	5	—	210	16	119	4·8
BEDFORDSHIRE.								
Ampthill - - -	605	536	—	—	63	1	5	
Bedford - - -	1,337	1,199	—	..	126	5	7	
Biggleswade - -	1,025	899	1	—	115	3	7	
Leighton Buzzard -	667	582	1	—	61	—	23	
Luton - - -	1,192	957	—	—	180	15	40	
Woburn - - -	367	320	—	—	39	4	4	
BERKS.								
Abingdon - - -	704	618	—	—	76	4	6	
Bradfield - - -	483	449	—	—	28	—	6	
Cookham - - -	506	424	—	—	30	22	30	
Easthampstead - -	323	303	1	—	16	—	3	
Faringdon - -	494	449	2	—	32	4	7	
Hungerford - -	567	513	1	—	43	9	1	
Newbury - - -	604	529	—	—	54	12	9	
Reading - - -	1,333	1,171	—	—	125	13	24	
Wallingford - -	479	446	—	—	31	—	2	
Wantage - - -	568	514	1	--	44	—	9	
Windsor - - -	870	759	—		54	3	54	
Wokingham - -	546	474	--	—	39	9	24	

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
BUCKS.							
Amersham - - -	616	547	—	—	63	2	4
Aylesbury - - -	749	645	—	—	81	11	12
Buckingham - -	393	330	2	—	41	1	19
Eton - - -	745	667	—	—	47	4	27
Newport Pagnell - -	900	810	—	—	81	3	6
Winslow - - -	281	244	—	—	32	2	3
Wycombe - - -	1,374	1,220	4	—	136	6	8
CAMBRIDGE.							
Cambridge - -	933	806	3	—	95	14	15
Caxton and Arrington -	450	413	—	—	35	—	2
Chesterton - -	936	812	1	—	100	1	22
Ely - - -	747	643	—	—	74	6	24
Linton - - -	447	395	—	—	29	9	14
Newmarket - -	890	765	—	—	91	1	33
North Witchford - -	562	493	—	—	56	7	6
Whittlesey - -	218	194	—	—	19	1	4
Wisbeach - - -	1,058	921	—	—	123	2	12
CHESHIRE.							
Altrincham - -	1,714	1,535	1	—	137	8	33
Birkenhead - -	3,550	2,990	3	—	346	19	192
Tarvin - - -	342	302	—	—	25	—	15
Chester - - -	1,483	1,277	2	—	179	7	18
Congleton - - -	1,394	1,231	—	—	148	6	9
Macclesfield - -	2,041	1,743	4	—	247	24	23
Nantwich - - -	2,092	1,750	2	1	181	15	143
Northwich - -	1,591	1,444	—	—	136	1	10
Runcorn - - -	1,194	1,067	1	—	114	2	10
Stockport - - -	3,913	3,346	2	1	477	10	77
Wirrall - - -	773	712	—	—	44	1	16
CORNWALL.							
Austell, St. - -	1,168	1,018	—	—	119	2	29
Bodmin - - -	595	509	—	—	56	—	30
Camelford - -	264	242	—	—	19	1	2
Columb, St., Major -	569	513	—	—	41	4	11
Falmouth - - -	700	591	1	—	86	9	13
Germans, St. - -	487	439	—	—	41	1	6
Helston - - -	821	683	1	—	83	20	34
Launceston - -	544	483	—	—	52	6	3
Liskeard - - -	940	815	—	—	98	11	16
Penzance - - -	1,703	1,395	—	—	251	34	23
Redruth - - -	1,693	1,423	1	—	224	8	37
Stratton - - -	201	168	—	—	16	1	16
Truro - - -	1,075	898	—	—	125	19	33
CUMBERLAND.							
Alston with Garrigill -	171	153	—	—	16	—	2
Bootle - - -	404	354	—	—	39	3	8
Brampton - - -	304	267	—	—	34	1	2
Carlisle - - -	1,534	1,368	—	—	145	3	18
Cockermouth - -	2,021	1,793	3	—	197	8	20
Longtown - - -	255	225	—	—	26	2	2
Penrith - - -	675	601	1	—	68	5	5
Whitehaven - -	2,212	1,893	—	—	209	21	89
Wigton - - -	698	610	—	—	73	1	14

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
DERBY.							
Ashbourne	622	562	1	—	48	—	11
Bakewell	895	789	—	—	80	—	26
Belper	2,253	2,045	2	—	187	1	18
Chapel-en-le-Frith	539	466	—	—	47	4	22
Chesterfield	4,106	3,516	4	—	500	9	77
Derby	2,577	2,208	7	—	310	13	39
Glossop	696	564	—	—	91	6	35
Hayfield	393	347	1	—	35	3	7
Shardlow	1,281	1,117	1	—	116	6	41
DEVON.							
Axminster	560	493	1	—	52	1	13
Barnstaple	1,096	975	1	—	87	22	11
Bideford	586	537	—	—	37	3	9
Crediton	535	472	—	—	40	11	12
East Stonehouse	515	459	—	—	51	1	4
Exeter	1,057	865	—	—	143	17	32
Holsworthy	268	237	—	—	24	4	3
Honiton	748	663	8	—	45	—	32
Kingsbridge	610	563	—	—	42	1	4
Newton Abbot	1,929	1,680	—	—	165	34	50
Okehampton	560	470	1	—	36	7	46
Plymouth	2,133	1,791	2	—	224	32	84
Plympton St. Mary	622	543	—	—	52	12	15
South Molton	527	476	1	—	37	2	11
Stoke Damerel	1,442	1,301	—	—	101	18	22
Tavistock	865	767	3	—	58	—	37
Thomas, St.	1,434	1,276	2	—	106	14	36
Tiverton	857	758	—	—	81	4	14
Torrington	466	410	—	—	36	6	14
Totnes	1,093	1,000	5	—	76	—	12
DORSET.							
Beaminster	396	343	—	—	39	1	13
Blandford	371	291	—	—	23	6	51
Bridport	496	434	—	—	40	5	17
Cerne	201	184	—	—	12	3	2
Dorchester	497	446	—	—	48	1	2
Poole	520	453	—	—	40	3	24
Shaftesbury	359	317	—	—	27	9	6
Sherborne	387	333	1	—	33	—	20
Sturminster	295	275	—	—	12	1	7
Wareham and Purbeck	502	441	—	—	41	4	16
Weymouth	829	742	1	—	56	13	17
Wimborne and Cranborne	505	456	—	—	38	2	9
DURHAM.							
Auckland	3,811	3,149	3	2	519	4	134
Chester-le-Street	1,902	1,622	1	1	235	1	42
Darlington	1,826	1,521	2	1	218	11	73
Durham	2,896	2,401	15	—	326	31	123
Easington	1,943	1,576	—	—	248	50	69
Gateshead	4,226	3,365	1	—	537	21	302
Hartlepool	1,965	1,707	1	—	232	5	20
Houghton-le-Spring	1,479	1,261	2	—	167	6	43
Lanchester	2,333	2,006	1	2	264	8	52

—		Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
DURHAM—*cont.*								
Sedgefield	- -	841	690	—	—	100	4	47
South Shields	- -	3,960	3,200	6	1	498	34	221
Stockton -	- -	4,758	3,782	7	—	544	137	288
Sunderland	- -	4,985	4,278	14	—	526	11	156
Teesdale -	- -	693	608	—	—	69	4	12
Weardale -	- -	722	624	—	—	86	3	9
ESSEX.								
Billericay -	- -	466	400	1	—	47	2	16
Braintree -	- -	533	485	—	—	42	3	3
Chelmsford	- -	996	917	—	—	61	8	10
Colchester	- -	838	737	1	—	80	4	16
Dunmow -	- -	562	521	—	—	34	1	6
Epping -	- -	617	542	2	—	42	2	29
Halstead -	- -	565	492	1	—	46	6	20
Lexden and Winstree	-	843	784	—	—	50	2	7
Maldon -	- -	769	678	—	—	60	3	28
Ongar -	- -	335	300	—	—	19	1	15
Orsett -	- -	481	432	1	—	37	1	10
Rochford -	- -	755	667	3	—	65	6	14
Romford -	- -	1,107	977	2	—	83	1	44
Saffron Walden -	-	632	552	—	—	57	2	21
Tendring -	- -	950	763	—	—	87	9	91
West Ham	-	4,788	4,363	4	—	359	17	45
Witham -	- -	485	442	—	—	34	—	9
GLOUCESTER.								
Bristol -	- -	1,980	1,654	—	—	237	9	80
Cheltenham	- -	1,311	956	1	—	128	3	223
Chipping Sodbury	-	555	466	4	—	54	1	30
Cirencester	- -	643	572	—	—	46	5	20
Clifton -	- -	5,174	4,509	—	1	493	15	156
Dursley -	- -	377	325	—	—	28	18	6
Gloucester	- -	1,411	1,223	1	—	128	4	55
Newent -	- -	369	317	—	—	41	1	10
Northleach	- -	311	285	—	—	17	—	9
Stow-on-the-Wold	-	263	237	2	—	5	1	18
Stroud -	- -	1,258	1,155	2	—	83	4	14
Tetbury -	- -	174	154	—	—	17	2	1
Tewkesbury	- -	404	358	2	—	35	3	6
Thornbury	- -	525	483	—	—	38	1	3
Westbury-on-Severn	-	993	873	—	—	80	7	33
Wheatenhurst	- -	212	189	—	—	23	—	—
Winchcomb	- -	344	305	—	1	31	1	6
HEREFORD.								
Bromyard	- -	355	310	1	—	34	3	7
Dore -	- -	244	221	—	—	18	1	4
Hereford -	- -	934	802	—	—	92	3	37
Kington -	- -	329	282	—	—	30	3	14
Ledbury -	- -	355	307	—	—	25	2	21
Leominster	- -	449	361	3	—	49	1	35
Ross -	- -	472	418	—	—	33	3	18
Weeobly -	- -	236	194	1	—	25	—	16

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Digest of Vaccination Returns.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
HERTS.							
Albans, St. - -	652	588	1	—	56	3	4
Barnet - - -	809	741	—	—	50	1	17
Berkhampstead - -	442	378	—	—	44	3	17
Bishop's Stortford -	695	641	3	—	44	2	5
Buntingford - -	175	166	—	—	8	—	1
Hatfield - - -	212	187	—	—	22	1	2
Hemel Hempstead -	501	426	—	—	58	5	12
Hertford - - -	480	433	—	—	37	7	3
Hitchin - - -	957	877	—	—	75	—	5
Royston - - -	700	614	1	—	76	—	9
Ware - - -	508	462	—	—	35	—	11
Watford -	876	779	3	—	72	7	15
Welwyn - - -	72	62	—	—	10	—	—
HUNTINGDON.							
Huntingdon - -	623	560	—	—	54	6	3
Ives, St. - - -	546	500	—	—	41	3	2
Neots, St. - - -	588	536	1	—	44	2	5
KENT (extra metropolitan).							
Ashford, East - -	375	347	—	—	20,	2	6
Ashford, West - -	611	546	—	—	48	4	13
Blean - - -	631	572	—	—	53	2	4
Bridge - - -	379	341	1	—	31	3	3
Bromley - -	1,275	1,068	—	—	95	2	110
Canterbury - -	532	470	—	—	51	—	11
Cranbrook - -	430	378	—	—	32	8	12
Dartford - - -	1,547	1,418	2	—	99	9	19
Dover - - -	1,093	932	2	—	101	14	44
Eastry - - -	756	670	1	—	61	14	10
Elham - - -	945	847	—	—	76	11	11
Faversham - -	811	746	1	—	60	1	3
Gravesend and Milton -	646	586	1	—	48	1	10
Hollingbourn - -	454	402	2	—	42	4	4
Hoo - - -	131	118	—	—	12	—	1
Maidstone - -	1,367	1,199	1	—	116	18	33
Malling - - -	878	793	1	—	67	2	15
Medway - - -	1,929	1,718	3	—	148	19	41
Milton - - -	816	769	1	—	40	1	5
North Aylesford - -	900	800	—	—	81	1	18
Romney Marsh - -	211	197	—	—	12	—	2
Seven Oaks - -	822	741	—	—	58	1	22
Sheppey - - -	576	513	—		48	5	10
Tenterden - -	339	302	—	—	27	1	9
Thanet, I. of - -	1,249	1,149	—	—	81	5	14
Tonbridge - -	1,497	1,359	4	—	101	10	23
LANCASHIRE.							
Ashton-under-Lyne -	5,559	4,861	2	—	592	13	91
Barrow-in-Furness -		Included in Ulverstone.					
Barton-upon-Irwell -	2,086	1,756	—	—	212	26	92
Blackburn -	6,248	5,591	2	—	621	4	30
Bolton - - -	6,724	5,994	4	—	639	—	87
Burnley - - -	3,737	3,210	3	—	444	22	58
Bury - - -	4,306	3,811	4	—	393	18	80

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
LANCASHIRE—*cont.*							
Chorley - - -	1,755	1,530	1	—	180	16	28
Chorlton - - -	8,757	7,299	6	1	978	17	456
Clitheroe - - -	711	622	—	—	67	8	14
Fylde, The - -	1,114	965	—	—	115	4	30
Garstang - - -	392	353	—	—	35	—	4
Haslingden - -	3,157	2,819	2	—	303	8	25
Lancaster - -	1,127	999	1	—	94	12	21
Leigh - - -	1,962	1,754	2	—	181	—	25
Liverpool - - -	8,169	6,711	4	—	995	10	449
Lunesdale - -	200	183	—	—	14	2	1
Manchester - -	6,809	5,703	4	—	825	16	261
Oldham - - -	5,403	4,622	6	—	595	39	141
Ormskirk - - -	2,233	1,983	2	—	187	8	53
Prescot - - -	4,343	3,585	6	—	529	45	178
Preston - - -	4,605	4,001	—	—	427	6	171
Prestwich - -	3,455	3,008	1	—	326	15	105
Rochdale - - -	4,110	3,555	1	3	427	26	98
Salford - - -	6,123	5,117	3	—	645	93	265
Todmorden - -	1,169	1,022	1	2	114	4	26
Toxteth Park - -	3,748	3,107	1	—	406	14	215
Ulverstone - -	3,348	2,850	1	—	296	52	149
Warrington - -	2,481	2,185	2	1	251	12	30
West Derby - -	11,505	9,827	15	1	1,163	26	473
Wigan - - -	5,851	5,164	1	1	608	7	70
LEICESTER.							
Ashby-de-la-Zouch -	1,285	958	—	—	146	3	128
Barrow-on-Soar - -	874	735	—	—	109	5	25
Billesdon - - -	206	171	—	—	21	1	13
Blaby - - -	604	507	—	—	73	18	6
Hinckley -	644	565	—	—	77	—	2
Leicester - - -	4,365	3,590	9	—	648	19	104
Loughborough - -	946	806	—	—	117	1	22
Lutterworth - -	329	298	—	—	28	—	3
Market Bosworth -	502	438	—	—	60	1	3
Market Harborough -	485	416	—	—	53	4	12
Melton Mowbray - -	560	481	—	—	59	6	14
LINCOLNSHIRE.							
Boston - - -	1,252	1,056	1	—	128	6	61
Bourn - - -	666	567	—	—	52	19	28
Caistor - - -	1,880	1,401	3	5	257	85	179
Gainsborough - -	869	688	2	—	92	19	68
Glanford Brigg - -	1,263	1,108	2	—	126	3	24
Grantham - -	1,021	928	—	—	83	—	10
Holbeach - - -	664	575	—	—	77	2	10
Horncastle - -	686	601	1	—	59	4	21
Lincoln - - -	1,960	1,415	1	—	289	48	207
Louth - - -	1,045	896	—	—	96	14	39
Sleaford - - -	831	728	3	—	94	1	5
Spalding - - -	767	694	—	1	56	3	18
Spilsby - - -	835	696	1	—	89	13	26
Stamford - - -	553	489	1	—	40	11	12

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Digest of Vaccination Returns.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
MIDDLESEX (extra metropolitan).							
Brentford - - -	2,560	2,206	1	—	206	—	147
Edmonton - -	3,196	2,754	6	—	235	34	167
Hendon - - -	1,442	1,055	13	—	145	21	208
Staines - - -	679	569	2	—	65	9	34
Uxbridge - - -	784	699	2	—	62	1	20
MONMOUTHSHIRE.							
Abergavenny - -	860	739	—	—	84	9	28
Bedwelty - - -	2,523	2,256	4	1	229	—	33
Chepstow - - -	557	498	—	—	41	3	15
Monmouth - -	1,122	1,003	—	—	97	2	20
Newport - - -	2,573	2,296	1	—	229	13	34
Pontypool - -	1,528	1,153	—	—	136	23	216
NORFOLK.							
Aylsham - - -	557	470	—	—	70	4	13
Blofield - - -	337	297	—	—	33	2	5
Depwade - -	726	613	4	—	74	8	27
Docking - - -	540	476	—	—	54	2	8
Downham - -	638	566	1	—	58	—	13
Erpingham - -	578	498	—	—	60	11	9
Faith, St. - - -	341	301	—	—	35	1	4
Flegg, E. and W. - -	315	265	—	—	28	1	21
Forehoe - - -	257	205	—	—	31	2	19
Freebridge Lynn - -	450	399	—	—	38	5	8
Guiltcross - -	383	271	—	—	30	1	31
Henstead - -	342	297	—	—	37	3	5
King's Lynn - -	507	454	—	—	47	2	4
Loddon and Clavering -	426	386	1	—	32	1	6
Mitford and Launditch -	763	677	—	—	66	3	17
Norwich - - -	2,617	2,231	9	—	323	2	52
Swaffham - - -	390	347	—	—	26	3	14
Thetford - - -	525	458	—	—	38	3	26
Smallburgh -	409	366	1	—	33	1	8
Walsingham - -	627	559	—	—	52	—	16
Wayland - - -	328	284	—	—	37	3	4
Yarmouth, Gt. - -	1,099	909	—	—	128	27	35
NORTHAMPTONSHIRE.							
Brackley - - -	411	329	1	—	56	4	21
Brixworth - -	387	350	1	—	29	1	6
Daventry - - -	582	517	—	—	51	1	13
Hardingstone - -	342	310	—	—	29	1	2
Kettering - - -	837	743	—	—	79	2	13
Northampton - -	2,066	1,670	3	—	271	4	118
Oundle - - -	446	404	2	—	36	—	4
Peterborough - -	1,286	1,131	—	—	134	2	19
Potterspury - -	370	299	—	—	42		25
Thrapston - - -	515	448	—	—	58		9
Towcester - - -	465	402	2	—	49		7
Wellingborough - -	1,253	1,020	—	—	158	16	59

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
NORTHUMBERLAND.							
Alnwick - - -	637	548	—	—	62	10	17
Belford - - -	145	134	—	—	10	—	1
Bellingham - -	197	178	—	—	18	1	—
Berwick-on-Tweed -	619	565	—	—	43	2	9
Castle Ward - -	704	617	—	1	78	—	8
Glendale - - -	294	279	—	—	12	—	3
Haltwhistle - -	267	248	—	—	18	—	1
Hexham - - -	1,092	947	—	—	93	3	49
Morpeth - - -	1,799	1,570	2	—	216	3	8
Newcastle-on-Tyne -	5,675	4,700	2	—	778	53	142
Rothbury - - -	196	176	—	—	13	5	2
Tynemouth - -	4,407	3,779	3	—	468	44	113
NOTTINGHAMSHIRE.							
Basford - - -	4,276	3,642	1	—	477	14	142
Bingham - - -	421	382	—	—	31	1	7
East Retford - -	699	622	—	—	66	—	11
Mansfield - - -	1,695	1,389	—	—	224	5	76
Newark - - -	972	840	—	—	109	1	22
Nottingham - -	3,183	2,486	7	—	425	69	196
Radford - - -	1,435	1,174	—	—	178	5	78
Southwell - -	583	521	—	—	48	3	11
Worksop - - -	1,059	939	1	—	99	9	11
OXFORDSHIRE.							
Banbury - - -	960	665	—	—	98	2	195
Bicester - - -	516	440	—	—	49	8	19
Chipping Norton - -	605	500	1	—	96	2	6
Headington - -	786	657	—	—	80	13	36
Henley - - -	538	472	—	—	42	3	21
Oxford - - -	654	548	3	1	74	4	24
Thame - - -	435	391	—	—	36	—	8
Witney - - -	794	708	—	—	70	2	14
Woodstock - -	457	412	1	—	33	4	7
RUTLAND.							
Oakham - - -	342	302	1	—	33	3	3
Uppingham - -	325	296	—	—	22	1	6
SALOP.							
Atcham - - -	1,328	1,195	—	—	115	5	13
Bridgnorth - -	435	379	—	—	41	6	9
Church Stretton - -	165	153	—	—	10	—	2
Cleobury Mortimer -	274	239	—	—	28	2	5
Clun - - -	332	273	4	—	30	3	22
Drayton - - -	458	411	—	—	45	—	2
Ellesmere - - -	386	353	—	—	20	2	11
Ludlow - - -	551	453	—	—	62	1	35
Madeley - - -	1,102	966	5	—	106	5	20
Newport - - -	430	379	—	—	39	1	11
Oswestry - - -	857	782	—	—	60	4	11
Shifnal - - -	409	343	1	—	34	1	30
Wellington - -	1,030	919	—	—	99	2	10
Wem - - -	263	236	—	—	25	1	1
Whitchurch - -	352	268	—	—	36	—	48

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
SOMERSET.							
Axbridge - - -	1,088	973	—	—	75	12	28
Bath - - -	1,845	1,511	—	—	196	11	127
Bedminster - -	2,270	1,967	5	—	208	42	48
Bridgwater - -	1,084	968	4	—	79	6	27
Chard - - -	839	730	—	—	91	8	10
Clutton - - -	838	756	—	—	53	3	26
Dulverton - -	182	170	—	—	7	3	2
Frome - - -	768	690	1	—	60	2	15
Keynsham - -	852	735	—	—	78	1	38
Langport - - -	475	405	—	—	29	1	40
Shepton Mallet - -	502	441	1	—	37	11	12
Taunton - - -	896	809	2	—	64	6	15
Wellington - -	531	480	3	—	31	—	17
Wells - - -	697	603	6	—	63	9	16
Williton - - -	609	553	—	—	42	9	5
Wincanton - -	581	520	1	—	45	4	11
Yeovil - -	865	747	1	—	88	6	23
SOUTHAMPTON.							
Alresford - - -	210	192	—	—	14	—	4
Alton - - -	488	449	—	—	26	—	13
Alverstoke - -	719	671	—	—	47	—	1
Andover - - -	490	443	—	—	41	1	5
Basingstoke - -	502	453	—	—	21	10	18
Catherington - -	66	59	—	—	4	—	3
Christchurch - -	587	484	—	—	58	23	22
Droxford - - -	337	311	—	—	21	1	4
Fareham - - -	458	422	—	—	27	—	9
Fordingbridge - -	199	180	—	—	15	—	4
Hartley Wintney - -	560	497	—	—	36	1	26
Havant - - -	247	204	—	—	20	3	20
Hursley - - -	77	68	—	—	8	1	—
Kingsclere - -	290	271	—	—	15	—	4
Lymington - -	362	320	—	—	20	7	15
New Forest - -	413	376	—	—	29	1	7
Petersfield - -	307	287	—	—	13	4	3
Portsea Island - -	3,829	3,437	4	—	320	17	51
Ringwood - - -	168	158	—	—	7	—	3
Romsey - - -	340	266	—	—	30	4	40
Southampton - -	1,615	1,352	2	—	161	18	82
South Stoneham - -	1,045	886	—	—	100	7	52
Stockbridge - -	207	187	—	—	17	—	3
Whitchurch - -	180	151	—	—	21	2	6
Wight, Isle of - -	2,112	1,833	7	—	157	54	61
Winchester, New - -	772	679	1	—	68	10	14
STAFFORDSHIRE.							
Wolstanton and Burslem -	3,574	3,092	1	—	430	13	38
Burton-on-Trent - -	2,349	1,426	1	—	260	9	653
Cheadle - - -	818	748	—	—	56	2	12
Leek - - -	1,213	952	—	1	110	14	136
Lichfield - - -	1,283	1,137	—	—	113	9	24
Newcastle-under-Lyme -	1,378	1,175	1	—	133	1	68
Penkridge - -	1,184	1,027	—	—	122	8	27
Seisdon - - -	519	455	—	—	50	2	12
Stafford - - -	1,001	867	—	—	89	4	41
Stoke-on-Trent - -	4,358	3,747	4	—	470	4	133

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
STAFFORDSHIRE—*cont.*							
Stone - - -	912	839	1	—	57	2	13
Tamworth - -	700	575	—	—	86	2	37
Uttoxeter - - -	420	384	—	—	29	2	5
Walsall - - -	3,494	2,967	4	—	398	14	111
West Bromwich - -	5,011	4,450	5	3	476	8	69
Wolverhampton - -	5,224	4,593	5	—	570	2	54
SUFFOLK.							
Blything - - -	828	741	—	-	55	8	24
Bosmere and Claydon -	518	459	1	—	45	4	9
Bury St. Edmunds -	470	417	—	—	41	4	8
Cosford - - -	521	448	1	—	51	2	19
Hartismere - -	518	474	—	—	33	2	9
Hoxne - - -	420	370	—	—	35	4	11
Ipswich - - -	1,528	1,357	6	—	124	4	37
Mildenhall - -	306	269	—	—	27	1	9
Mutford and Lothingland -	1,207	1,040	—	—	114	11	42
Plomesgate - -	598	545	1	—	36	4	12
Risbridge - - -	643	580	—	—	56	—	7
Samford - - -	355	319	—	—	22	5	9
Stow - - -	716	635	1	—	52	2	26
Sudbury - - -	953	799	—	—	89	—	65
Thingoe - - -	506	465	—	—	30	1	10
Wangford - - -	423	360	—	—	36	9	18
Woodbridge - -	636	581	—	—	43	1	11
SURREY (extra metropolitan.)							
Chertsey - - -	785	666	1	—	63	12	43
Croydon - - -	3,003	2,467	3	—	285	39	209
Dorking - - -	461	414	1	—	40	1	5
Epsom - -	983	797	—	—	71	18	97
Farnham - - -	1,535	1,288	7	—	155	4	81
Godstone - - -	376	339	1	—	28	—	8
Guildford - - -	1,062	949	—	—	80	11	22
Hambledon - -	475	430	1	—	27	6	11
Kingston - - -	1,960	1,733	2	1	132	25	67
Reigate - - -	831	767	2		36	6	20
Richmond - -	764	685	1	—	64	1	13
SUSSEX.							
Battle - - -	440	410	—	—	25	3	2
Brighton - - -	2,661	2,392	4	—	228	8	29
Chailey - - -	289	264	—	—	22	2	1
Chichester - -	232	183	—	—	22	3	24
Cuckfield - - -	620	550	—	—	43	6	21
Eastbourne - -	574	462	—	—	51	3	58
East Grinstead - -	588	522	—	—	49	3	14
East Preston - -	663	610	—	—	38	7	8
Hailsham - - -	432	367	—	—	31	3	31
Hastings - - -	1,099	857	—	—	124	14	104
Horsham - - -	627	578	2	—	35	1	11
Lewes - - -	323	278	1	—	30	9	5

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
SUSSEX—*cont.*							
Midhurst - - -	426	397	—	—	25	2	2
Newhaven - - -	219	187	4	—	17	2	9
Petworth - - -	295	258	—	—	26	9	2
Rye - - -	361	310	4	—	39	—	8
Steyning - - -	1,021	865	1	—	76	16	63
Thakeham - -	281	257	—	—	20	2	2
Ticehurst - - -	588	523	—	—	38	2	25
Uckfield - - -	699	642	—	—	49	3	5
Westbourne - -	226	197	—	—	11	7	11
West Firle - -	65	59	—	—	5	—	1
West Hampnett - -	562	506	1	—	36	12	7
WARWICKSHIRE.							
Alcester - - -	646	566	—	—	62	1	17
Aston - - -	7,200	6,216	12	20	773	5	174
Atherstone - -	478	409	—	—	57	—	12
Birmingham - -	9,652	8,020	25	13	1,037	4	553
Coventry - - -	1,582	1,341	—	—	187	15	39
Foleshill - - -	765	620	—	—	107	—	38
Meriden - -	288	258	—	—	28	2	—
Nuneaton - - -	464	385	—	—	44	3	32
Rugby - - -	664	585	—	1	71	3	4
Solihull - - -	415	365	1	—	32	5	12
Southam - - -	310	262	—	—	38	6	4
Stratford-on-Avon -	674	615	—	—	45	1	13
Warwick - - -	1,354	1,235	—	—	98	5	16
WESTMORELAND.							
East Ward - -	500	425	—	—	59	3	13
Kendal - - -	1,348	1,250	—	—	87	4	7
West Ward - -	270	253	—	—	17	—	—
WILTSHIRE.							
Alderbury - -	716	646	2	—	64	—	4
Amesbury - -	201	192	—	—	8	—	1
Bradford - - -	324	299	—	—	24	—	1
Calne - - -	281	259	—	—	17	2	3
Chippenham - -	640	578	2	—	52	1	7
Cricklade and Wootton Bassett.	397	311	—	—	34	—	52
Devizes - - -	615	557	—	—	49	4	5
Highworth and Swindon -	1,178	1,049	—	—	96	8	25
Malmesbury - -	435	396	—	—	28	6	5
Marlborough - -	286	277	—	—	7	—	2
Melksham - - -	594	490	—	—	83	11	10
Mere - - -	210	184	—	—	26	—	—
Pewsey - - -	340	321	—	—	17	—	2
Tisbury - - -	294	261	—	—	27	2	4
Warminster - -	386	356	—	—	25	1	4
Westbury and Whorwelsdown.	356	327	—	—	26	—	3
Wilton - - -	336	290	—	—	36	1	9

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
WORCESTERSHIRE.							
Bromsgrove - -	1,020	900	—	—	107	4	9
Droitwich - - -	723	674	3	—	34	5	7
Dudley - - -	6,629	5,584	1	2	770	39	233
Evesham - - -	483	413	—	—	62	2	6
Kidderminster - -	1,197	1,018	—	—	145	4	80
King's Norton - -	2,641	2,351	9	3	213	20	45
Martley - - -	460	415	—	—	35	1	9
Pershore - - -	422	385	—	—	37	—	—
Shipston-on-Stour- -	578	489	—	—	47	1	41
Stourbridge - -	3,360	2,883	2	—	394	6	75
Tenbury - - -	218	178	—	—	17	4	19
Upton-on-Severn - -	566	480	—	—	30	5	51
Worcester - - -	1,021	744	3	—	127	—	147
YORKSHIRE.							
East Riding.							
Beverley - - -	784	530	1	—	100	7	96
Bridlington - -	472	402	—	—	57	1	12
Driffield - - -	678	573	2	—	87	—	16
Howden - - -	421	368	—	—	48	2	3
Kingston-upon-Hull -	2,716	2,324	3	—	304	5	80
Patrington - -	261	223	—	—	32	—	6
Pocklington - -	451	378	2	—	46	7	18
Sculcoates - -	3,239	2,792	7	—	322	12	106
Skirlaugh - - -	309	266	—	—	37	2	4
York - - -	2,208	1,858	2	—	234	18	96
YORKSHIRE.							
North Riding.							
Aysgarth - - -	162	140	—	—	10	9	8
Bedale - - -	221	200	—	—	20	—	1
Easingwold - -	256	232	—	—	16	1	7
Guisborough - -	2,475	1,913	2	2	344	11	203*
Helmsley Blackmoor -	178	163	—	—	15	—	—
Kirkby Moorside - -	166	143	—	—	17	1	5
Leyburn - - -	262	232	—	—	29	—	1
Malton - - -	713	623	—	—	59	9	22
Northallerton - -	342	303	—	—	28	8	3
Pickering - - -	496	395	2	—	62	8	29
Reeth - - -	158	138	—	—	19	1	—
Richmond - -	371	322	—	—	43	1	5
Scarborough - -	1,209	1,017	2	—	138	30	22
Stokesley - - -	360	324	—	—	32	2	2
Thirsk - - -	391	340	—	—	40	2	9
Whitby - - -	973	828	—	—	116	8	21
YORKSHIRE.							
West Riding.							
Barnsley - - -	3,123	2,643	—	—	379	21	80
Bramley - - -	1,986	1,678	2	—	256	2	48
Bradford - -	6,443	5,335	10	2	782	—	814
Bierley, North - -	4,548	3,902	1	2	489	23	131
Dewsbury - - -	5,510	2,713	1	6	844	9	1,937
Doncaster - - -	1,668	1,428	3	—	164	27	46

* No return from Danby registration sub-district (73 births).

App. No. 1.

Digest of Vaccination Returns.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
YORKSHIRE—*cont.*							
Ecclesall Bierlow - -	3,876	3,340	9	—	391	11	125
Goole - - -	683	587	—	—	69	1	26
Halifax - - -	5,777	5,141	2	—	592	9	33
Hemsworth - -	241	212	1	—	19	—	9
Holbeck - - -	965	814	—	—	135	—	16
Huddersfield - -	5,203	4,604	3	—	519	9	68
Hunslet - - -	2,322	2,020	3	1	269	2	27
Keighley - - -	1,947	648	—	—	328	8	963
Knaresborough - -	535	464	1	—	51	3	16
Leeds - - -	7,121	6,197	4	—	819	9	92
Ouseburn, Great - -	371	332	1	—	33	1	4
Pateley Bridge - -	282	257	—	—	23	—	2
Penistone - - -	615	549	—	—	58	4	4
Pontefract - - -	1,827	1,546	—	1	213	6	61
Ripon - - -	474	408	—	—	49	4	13
Rotherham - -	3,092	2,669	4	—	322	20	77
Saddleworth - -	720	643	—	—	56	—	21
Sedbergh - - -	147	105	1	—	16	—	25
Selby - - -	503	444	—	—	53	3	3
Settle - - -	475	422	—	—	45	2	6
Sheffield - - -	7,579	6,019	7	—	1,047	41	465
Skipton - - -	1,090	924	2	—	125	8	31
Tadcaster - - -	785	668	2	—	81	5	29
Thorne - - -	546	397	—	—	85	6	58
Wakefield - - -	3,340	2,716	3	—	402	3	216
Wetherby - - -	429	344	7	—	48	4	26
Wharfedale - -	1,566	1,279	—	—	186	22	79
Wortley - - -	1,374	1,143	—	—	147	7	77
ANGLESEY.							
Anglesey - - -	398	342	—	—	39	4	13
Holyhead - - -	490	383	5	—	49	—	53
BRECKNOCK.							
Brecknock - -	483	437	—	1	40	—	5
Builth - -	256	223	1	—	22	1	9
Crickhowell - -	798	676	—	—	93	3	26
Hay - - -	319	276	—	—	33	1	9
CARDIGAN.							
Aberaeron - -	355	309	—	—	33	3	10
Aberystwith - -	747	641	—	—	72	10	24
Cardigan - - -	476	422	—	—	34	4	16
Lampeter - - -	285	238	—	—	31	7	9
Tregaron - - -	288	247	—	—	24	5	12
CARMARTHEN.							
Carmarthen - -	1,023	906	—	—	85	5	27
Llanelly - - -	1,707	1,539	1	—	147	10	10
Llandilo Fawr - -	569	515	—	—	50	1	3
Llandovery - -	464	409	—	—	41	11	3
Newcastle-in-Emlyn -	524	456	—	—	60	1	7

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead, Unvaccinated.	Vaccination postponed.	Remaining.
CARNARVON.							
Bangor and Beaumaris -	1,065	949	1	—	102	3	10
Carnarvon - -	1,372	1,153	5	—	180	22	12
Conway - - -	455	403	—	—	40	5	7
Pwllheli - - -	598	533	—	—	53	5	7
DENBIGH.							
Llanrwst - - -	372	311	—	—	32	15	14
Ruthin - - -	373	340	—	—	30	1	2
Wrexham - - -	2,084	1,817	—	—	200	8	59
FLINT.							
Asaph, St. - -	752	676	—	—	70	—	6
Hawarden - -	611	565	—	—	42	2	2
Holywell - - -	1,587	1,396	1	—	136	12	42
GLAMORGAN.							
Bridgend and Cowbridge -	1,346	1,201	1	—	126	4	14
Cardiff - - -	3,280	2,641	2	—	381	51	205
Gower - - -	345	314	—	—	24	6	1
Merthyr Tydfil - -	4,791	4,242	3	—	482	3	61
Neath - - -	2,532	2,277	1	—	206	7	41
Pontardawe - -	594	547	—	—	41	4	2
Pontypridd - -	3,281	2,685	10	—	405	26	155
Swansea - - -	3,436	2,928	1	—	296	16	195
MERIONETH.							
Bala - - -	174	150	—	—	21	3	—
Corwen - - -	524	450	—	—	50	9	15
Dolgelly - - -	454	404	—	—	41	5	4
Festiniog - - -	949	816	—	—	114	10	9
MONTGOMERY.							
Llanfyllin - - -	596	512	—	—	59	15	10
Machynlleth - -	396	345	—	—	40	3	8
Forden - - -	572	536	—	—	28	2	6
Newtown and Llanidloes -	816	651	3	—	61	34	67
PEMBROKE.							
Haverfordwest - -	948	799	1	—	105	25	18
Narberth - - -	584	527	—	—	39	9	9
Pembroke - -	900	774	1	—	94	22	9
RADNOR.							
Knighton - - -	297	203	—	—	23	1	70
Presteigne - -	144	123	—	—	11	—	10
Rhayader - - -	182	133	—	—	14	—	35

App. No. 2.

Inspection of Public Vaccination.

Union.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Gloucester - -	2	1	—	—	—	19 18 0	Dr. Ballard.
Godstone - - -	5	3	1	4 13 4	8 13 0	27 0 4	„ Stevens.
Grantham - - -	7	3	—	1 5 0	4 17 0	10 7 0	„ Beard.
Greenwich - -	2	2	—	49 18 0	120 9 0	170 2 0	„ Stevens.
Guildford - - -	9	7	1	3 2 0	18 14 0	71 11 4	Do.
Guiltcross - - -	5	2	—	3 16 0	6 0 0	9 16 0	„ Airy.
Haltwhistle - -	4	—	—	—	—	—	Mr. Power
Hambledon - -	5	2	1	2 17 4	8 10 0	16 18 4	Dr. Stevens.
Hampstead - -	1	—	—	—	—	—	Do.
Hartismere - -	5	4	—	5 3 0	9 10 0	32 5 0	„ Airy.
Hartley Wintney -	6	4	—	6 13 0	10 11 0	36 1 0	„ Stevens.
Hatfield - - -	3	—	—	—	—	—	„ Thorne.
Havant - - -	3	2	—	3 3 0	3 18 0	7 1 0	„ Stevens.
Hayfield - - -	1	—	—	—	—	—	„ Beard.
Helston - - -	4	—	1	—	—	12 16 0	„ Blaxall.
Hemel Hempstead -	4	—	—	—	—	—	„ Thorne.
Henstead - - -	4	1	—	—	—	4 4 0	„ Airy.
Hereford - - -	4	1	—	—	—	29 3 0	Do.
Hertford - - -	5	1	—	—	—	11 10 0	„ Thorne.
Hexham - - -	11	2	—	1 4 0	6 5 0	7 9 0	Mr. Power.
Hinckley - - -	5	3	—	2 0 0	22 9 0	27 14 0	Dr. Ballard.
Hitchin - - -	5	4	1	6 19 4	19 2 0	60 5 4	„ Thorne.
Holbeach - - -	5	3	—	5 9 0	10 13 0	25 2 0	„ Beard.
Holborn - - -	4	4	—	31 18 0	95 9 0	216 11 0	„ Stevens.
Holsworthy - -	5	—	—	—	—	—	„ Blaxall.
Honiton - - -	13	2	—	1 16 0	9 6 0	11 2 0	Do.
Horncastle - -	6	3	—	5 16 0	7 17 0	20 8 0	„ Beard.
Howden - - -	4	2	—	3 3 0	3 17 0	7 0 0	Do.
Hoxne - - -	8	6	—	0 6 0	8 3 0	23 0 0	„ Airy.
Hursley - - -	1	1	—	—	—	6 6 0	„ Stevens.
Ipswich - - -	1	1	—	—	—	72 16 0	„ Airy.
Kendal - - -	8	4	—	4 3 0	14 17 0	35 9 0	Mr. Power.
Kensington - -	3	3	—	15 10 0	97 18 0	149 17 0	Dr. Stevens.
Keynsham - - -	1	1	—	—	—	59 12 0	„ Blaxall.
Kidderminster - -	5	2	—	8 4 0	45 14 0	53 18 0	Mr. Power.
Kingsbridge - -	8	3	1	2 19 0	9 9 0	23 18 0	Dr. Blaxall.
Kingsclere - - -	3	1	—	—	—	8 3 0	„ Stevens.
Kings Lynn - -	1	—	—	—	—	—	„ Airy.
Kings Norton - -	7	3	1	3 8 8	63 7 0	91 9 8	Mr. Power.
Kingston-on-Hull -	2	1	—	—	—	67 8 0	Dr. Beard.
Kingston-on-Thames	11	7	—	3 5 0	16 4 0	53 9 0	„ Stevens.
Kington - - -	5	2	—	3 15 0	9 18 0	13 13 0	„ Airy.
Langport - - -	6	2	—	1 13 0	16 19 0	18 12 0	„ Blaxall.
Launceston - -	8	1	—	—	—	7 0 0	Do.
Leeds - - - -	7	6	—	3 10 0	111 11 0	336 18 0	Dr. Stevens.
Ledbury - - -	3	—	—	—	—	—	„ Airy.
Leicester - - -	2	1	—	—	—	79 13 0	„ Ballard.
Leighton Buzzard -	2	—	—	—	—	—	„ Thorne.
Leominster - -	2	1	—	—	—	15 10 0	„ Airy.
Lincoln - - -	11	6	—	1 3 0	10 12 0	28 4 0	„ Beard.
Liskeard - - -	7	2	—	3 17 0	12 0 0	15 17 0	„ Blaxall.
Liverpool - - -	3	3	—	47 18 0	104 15 0	235 7 0	„ Stevens.
Loddon and Clavering	4	3	—	6 11 0	10 3 0	23 10 0	„ Airy.
Longtown - - -	2	—	—	—	—	—	Mr. Power.
Loughborough -	4	4	—	4 3 0	28 5 0	55 5 0	Dr. Ballard.
Louth - - -	11	8	—	3 11 0	7 16 0	44 0 0	„ Beard.
Luton - - -	6	3	1	2 14 8	30 12 0	51 3 8	„ Thorne.
Lutterworth - -	5	2	—	3 11 0	4 6 0	7 17 0	„ Ballard.
Lymington - -	4	2	1	1 11 0	5 13 0	9 13 4	„ Stevens.
Manchester - -	3	3	—	56 7 0	62 3 0	179 4 0	„ Stevens.
Mansfield - -	6	1	—	—	—	9 15 0	„ Beard.
Market Bosworth -	6	2	—	3 15 0	6 18 0	10 13 0	„ Ballard.
Market Harborough	6	—	—	—	—	—	Do.
Martley - - -	6	—	—	—	—	—	Mr. Power.
Melton Mowbray -	5	1	—	—	—	6 6 0	Dr. Ballard.
Mildenhall - -	2	1	—	—	—	14 12 0	„ Airy.
Mitford and Launditch.	8	2	—	8 7 0	9 2 0	17 9 0	Do.

Union.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.						Total Sum awarded in the Union.			Inspector.
		1st Class Award.	2nd Class Award.	Minimum.			Maximum.						
				£	s.	d.	£	s.	d.	£	s.	d.	
Monmouth - -	6	3	—	3	18	0	41	8	0	50	13	0	Dr. Thorne.
Mutford and Lothingland.	3	1	—	—			—			22	12	0	„ Airy.
Newark - - -	10	2	—	5	5	0	6	3	0	11	8	0	„ Beard.
Newcastle-on-Tyne -	3	4	—	44	3	0	74	3	0	221	3	0	„ Stevens.
Newent - - -	3	2	—	6	8	0	11	10	0	17	18	0	„ Ballard.
New Forest - -	5	5	—	0	18	0	14	8	0	32	9	0	„ Stevens.
Newport (Mon.) -	8	3	—	10	14	0	78	3	0	104	3	0	„ Thorne.
Newton Abbot - -	11	6	—	5	3	0	14	19	0	51	8	0	„ Blaxall.
Northleach - -	5	1	—	—			—			5	17	0	„ Ballard.
Norwich - - -	1	—	—	—			—			—			„ Airy.
Nottingham - -	2	—	—	—			—			—			„ Beard.
Okehampton - -	6	—	—	—			—			—			„ Blaxall.
Olave, Saint - -	3	3	—	55	8	0	99	19	0	229	0	0	„ Stevens.
Patrington - -	5	2	—	3	0	0	3	0	0	6	0	0	„ Beard.
Penrith - - -	6	3	—	4	14	0	13	16	0	25	8	0	Mr. Power.
Penzance - - -	5	2	—	8	12	0	15	4	0	23	16	0	Dr. Blaxall.
Pershore - - -	5	5	—	3	12	0	14	8	0	43	15	0	Mr. Power.
Petersfield - -	4	3	1	3	12	0	6	13	0	20	12	0	Dr. Stevens.
Plomesgate - -	6	3	1	2	10	0	6	2	0	20	11	0	„ Airy.
Plymouth - - -	1	2	—	35	11	0	52	12	0	88	3	0	„ Blaxall.
Plympton, St. Mary	5	3	—	7	17	0	12	7	0	31	19	0	Do.
Pocklington - -	6	—	—	—			—			—			„ Beard.
Pontypool - -	3	1	1	6	14	8	55	1	0	61	15	8	„ Thorne.
Poplar - - -	4	3	—	22	15	0	56	1	0	110	17	0	„ Stevens.
Portsea Island - -	3	3	—	29	9	0	109	0	0	225	11	0	Do.
Prestwich - - -	6	2	—	45	10	0	71	17	0	117	7	0	„ Beard.
Radford - - -	2	—	—	—			—			—			„ Beard.
Reading - - -	1	1	—	—			—			53	17	0	„ Stevens.
Redruth - - -	6	4	—	7	11	0	19	11	0	49	15	0	„ Blaxall.
Reigate - - -	4	3	—	5	7	0	24	7	0	39	19	0	„ Stevens.
Richmond (Surrey) -	3	2	—	7	6	0	17	8	0	24	14	0	Do.
Ringwood - - -	1	1	—	—			—			12	12	0	Do.
Risbridge - - -	5	1	—	—			—			6	1	0	„ Airy.
Romsey - - -	5	2	—	0	19	0	4	19	0	5	18	0	„ Stevens.
Ross - - - -	4	—	1	—			—			5	16	0	„ Airy.
Rothbury - - -	6	—	—	—			—			—			Mr. Power.
Royston - - -	4	1	—	—			—			23	4	0	Dr. Thorne.
Salford - - -	3	2	—	77	16	0	113	1	0	190	17	0	„ Beard.
Samford - - -	5	3	—	1	9	0	11	5	0	15	10	0	„ Airy.
Saviour, Saint - -	5	4	—	30	3	0	70	12	0	204	14	0	„ Stevens.
Sculcoates - - -	6	3	—	2	19	0	53	14	0	69	11	0	„ Beard.
Shardlow - - -	8	4	—	9	5	0	20	5	0	56	12	0	Do.
Sheffield - - -	6	6	—	25	5	0	87	8	0	341	15	0	„ Stevens.
Shipston on Stour -	5	4	—	5	3	0	7	6	0	25	1	0	Mr. Power.
Shoreditch - - -	3	3	—	28	7	0	87	0	0	182	6	0	Dr. Stevens.
Skirlaugh - - -	5	3	—	0	19	0	3	13	0	7	11	0	„ Beard.
Sleaford - - -	7	3	—	4	16	0	14	19	0	28	2	0	Do.
Smallburgh - -	4	2	1	3	5	4	9	19	0	22	6	4	„ Airy.
Southampton - -	2	2	—	37	15	0	45	11	0	83	6	0	„ Stevens.
South Molton - -	9	1	—	—			—			2	6	0	„ Blaxall.
South Stoneham -	5	3	—	7	10	0	15	16	0	36	7	0	„ Stevens.
Southwell - - -	9	2	—	7	12	0	8	2	0	15	14	0	„ Beard.
Spalding - - -	10	1	1	0	8	8	7	18	0	8	6	8	Do.
Spilsby - - -	7	3	—	6	1	0	7	7	0	20	12	0	Do.
Stamford - - -	7	—	—	—			—			—			Do.
Stepney - - -	1	1	—	—			—			58	1	0	„ Stevens.
Stockbridge - -	2	2	—	8	16	0	9	5	0	18	1	0	Do.
Stockport - - -	5	2	—	19	9	0	55	14	0	75	3	0	„ Beard.
Stoke Damerel - -	9	2	—	28	14	0	39	5	0	67	19	0	„ Blaxall.
Stourbridge - -	7	3	1	12	5	0	43	8	0	114	2	8	Mr. Power.
Stow - - - -	8	—	—	—			—			—			Dr. Airy.
Stow-on-the-Wold -	3	1	—	—			—			6	13	0	„ Ballard.
Strand - - -	1	1	—	—			—			37	14	0	„ Stevens.
Stratton - - -	2	—	—	—			—			—			„ Blaxall.
Stroud - - -	6	4	—	9	11	0	25	13	0	61	11	0	„ Ballard.
Sudbury - - -	7	4	—	1	10	0	22	16	0	48	0	0	„ Airy.
Swaffham - - -	6	3	—	1	2	0	9	5	0	11	9	0	Do.

Union.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Tarvin - - -	2	2	—	10 5 0	18 1 0	28 6 0	Dr. Beard.
Taunton - - -	7	3	—	5 11 0	7 19 0	21 5 0	„ Blaxall.
Tavistock - - -	7	1	—	—	—	7 0 0	Do.
Tenbury - - -	2	1	—	—	—	8 5 0	Mr. Power.
Tetbury - - -	2	1	—	—	—	2 18 0	Dr. Ballard.
Tewkesbury - -	4	2	—	6 17 0	7 19 0	14 16 0	Do.
Thetford - - -	7	2	1	3 16 0	7 5 0	16 11 0	„ Airy.
Thingoe - - -	8	1	—	—	—	4 1 0	Do.
Thomas, St. - -	16	3	1	2 9 0	9 12 0	28 18 0	„ Blaxall.
Thornbury - -	4	2	—	11 11 0	11 16 0	23 7 0	„ Ballard.
Tiverton - - -	14	5	—	0 17 0	9 18 0	25 7 0	„ Blaxall.
Torrington - -	5	1	—	—	—	4 0 0	Do.
Totnes - - -	11	1	—	—	—	2 15 0	Do.
Toxteth Park - -	2	2	—	67 1 0	98 13 0	165 14 0	„ Beard.
Truro - - -	8	—	—	—	—	—	„ Blaxall.
Upton-on-Severn -	5	3	—	5 7 0	17 3 0	29 15 0	Mr. Power.
Uxbridge - - -	7	4	—	2 13 0	16 7 0	35 15 0	Dr. Thorne.
Wallingford - -	3	3	—	10 2 0	12 17 0	33 17 0	„ Stevens.
Walsingham - -	6	1	—	—	—	6 9 0	„ Airy.
Wangford - - -	2	1	—	—	—	20 11 0	Do.
Ware - - - -	8	3	—	3 0 0	8 19 0	18 3 0	„ Thorne.
Watford - - -	5	1	—	—	—	12 18 0	Do.
Wayland - - -	2	—	—	—	—	—	„ Airy.
Wellington (Som.) -	6	—	1	—	—	9 11 4	„ Blaxall.
Wells - - - -	4	1	—	—	—	10 16 0	Do.
Welwyn - - -	1	—	—	—	—	—	„ Thorne.
Weobley - - -	3	1	—	—	—	3 10 0	„ Airy.
Westbury-on-Severn	4	3	—	8 18 0	28 0 0	52 2 0	„ Ballard.
West Derby - -	6	3	—	33 0 0	155 18 0	312 1 0	„ Beard.
Westminster - -	2	2	—	17 3 0	28 16 0	45 19 0	„ Stevens.
West Ward - -	4	1	—	—	—	10 10 0	Mr. Power.
Wheatenhurst - -	2	1	—	—	—	10 8 0	Dr. Ballard.
Whitchurch (Hants)	3	2	—	3 8 0	7 0 0	10 8 0	„ Stevens.
Whitechapel - -	1	1	—	—	—	104 12 0	Do.
Whitehaven - -	6	2	—	3 10 0	39 15 0	43 5 0	Mr. Power.
Wight, Isle of - -	9	6	1	5 0 0	20 3 0	76 10 4	Dr. Stevens.
Wigton - - -	7	3	—	2 9 0	9 7 0	15 11 0	Mr. Power.
Williton - - -	7	1	1	1 10 8	6 15 0	8 5 8	Dr. Blaxall.
Winchcomb - -	2	2	—	5 19 0	15 2 0	21 1 0	„ Ballard.
Winchester, New -	4	4	—	5 18 0	24 3 0	44 13 0	„ Stevens.
Windsor - - -	3	3	—	6 2 0	29 9 0	52 11 0	Do.
Wirrall - - -	4	1	—	—	—	14 0 0	„ Beard.
Woburn - - -	3	2	—	5 18 0	6 1 0	11 19 0	„ Thorne.
Wokingham - -	4	1	1	5 4 0	7 16 0	13 0 0	„ Stevens.
Woodbridge - -	4	2	—	11 10 0	13 8 0	24 18 0	„ Airy.
Worcester - - -	1	1	—	—	—	40 7 0	Mr. Power.
Worksop - - -	7	2	—	5 7 0	7 12 0	12 19 0	Dr. Beard.
Yarmouth, Great -	1	1	—	—	—	28 6 0	„ Airy.
Yeovil - - -	7	2	—	6 5 0	9 2 0	15 7 0	„ Blaxall.
York - - - -	6	1	—	—	—	3 8 0	„ Beard.
Total -	1,536	701	42	—	—	12,513 8 4	

SUPPLEMENTARY LIST of AWARDS made in 1876 to PUBLIC VACCINATORS in UNIONS which were inspected in 1875.

				£ s. d.	£ s. d.	£ s. d.	
Crickhowell - -	2	1	—	—	—	12 5 0	Dr. Airy.
Goole - - - -	5	3	—	2 8 0	6 0 0	12 17 0	„ Beard.
Selby - - - -	5	2	—	0 19 0	5 3 0	6 2 0	Do.
Total -	12	6	—	—	—	31 4 0	

No. 3.

STATISTICS of the NATIONAL VACCINE ESTABLISHMENT and EDUCATIONAL VACCINATING STATIONS.

APP. No. 3.

National Vaccine Establishment.

I.—STAFF at end of 1876.

N.B.—The stations named in *italics* are Educational Vaccinating Stations, authorised by the Local Government Board.

—	Name.	Vaccinating Stations.	Days and Hours of Attendance.
Vaccinators supplying lymph for the public service, & salaried from the Parliamentary grant	1. Mr. J. F. Marson	*Surrey Chapel*	Tues., Thurs.; 1.
	2. Mr. W. E. G. Pearse	*Tottenham Court Chapel.*	Mon., Wednes.; 1.
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. Mr. Ellis S. Guest	*Manchester*	Monday; 2.
	2–5. Dr. Edmund Robinson.	*Birmingham*	2. Monday 3. Tuesday 4. Wednesday 5. Thusday } 11
	6. Dr. H. A. P. Robertson	*Bristol*	Wednesday; 10.
	7. Mr. A. B. Steele	*Liverpool*	Thursday; 2.
	8. Mr. E. L. Webb	*Pimlico*	Thursday; 10.
	9. Mr. J. Hawthorn	*Newcastle-on-Tyne.*	Wednesday; 3.
	10. Mr. W. E. G. Pearse	*Westminster*	Tuesday; 2.
	11–12. Mr. W. A. Sumner	*Marylebone*	Monday Wednesday } 11.
	13. Mr. C. T. Blackman	*Whitechapel*	Wednesday; 11.
	14. Mr. Frederick Holmes	*Leeds*	Tuesday; 2.30.
	15. Dr. Edward Lynes	Coventry	Tuesday; 12.
	16. Dr. Hugh Thomson	*Glasgow*	Monday; 12.
	17. Mr. C. Harriot Roper	*Exeter*	Thursday; 3.
	18. Mr. Robert W. Dunn	*Strand*	Thursday; 11.
	19. Mr. Matthew Brownfield	Bromley, Middlesex.	Tuesday; 3.
	20. Mr. John Broadbent	Ancoats	Wednesday; 2.
	21. Mr. W. Skinner	*Sheffield*	Tuesday; 3.
	22. Dr. A. C. Clarke	Salford	Thursday; 2.
	23. Mr. N. Miskin	Waterloo	Tuesday; 2.
	24. Mr. T. F. Morrish	Toxteth Park	Tuesday; 11.
Teachers of Vaccination not supplying lymph	Dr. W. Husband	*Edinburgh*	Wednes., Sat.; 12.
	Dr. R. D. Tannahill	*Glasgow*	Mond., Thurs.; 12.

Union.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Tarvin - - -	2	2	—	10 5 0	18 1 0	28 6 0	Dr. Beard.
Taunton - - -	7	3	—	5 11 0	7 19 0	21 5 0	„ Blaxall.
Tavistock - - -	7	1	—	—	—	7 0 0	Do.
Tenbury - - -	2	1	—	—	—	8 5 0	Mr. Power.
Tetbury - - -	2	1	—	—	—	2 18 0	Dr. Ballard.
Tewkesbury - -	4	2	—	6 17 0	7 19 0	14 16 0	Do.
Thetford - - -	7	2	1	3 16 0	7 5 0	16 11 0	„ Airy.
Thingoe - - -	8	1	—	—	—	4 1 0	Do.
Thomas, St. - -	16	3	1	2 9 0	9 12 0	28 18 0	„ Blaxall.
Thornbury - -	4	2	—	11 11 0	11 16 0	23 7 0	„ Ballard.
Tiverton - - -	14	5	—	0 17 0	9 18 0	25 7 0	„ Blaxall.
Torrington - -	5	1	—	—	—	4 0 0	Do.
Totnes - - -	11	1	—	—	—	2 15 0	Do.
Toxteth Park - -	2	2	—	67 1 0	98 13 0	165 14 0	„ Beard.
Truro - - -	8	—	—	—	—	—	„ Blaxall.
Upton-on-Severn	5	3	—	5 7 0	17 3 0	29 15 0	Mr. Power.
Uxbridge - - -	7	4	—	2 13 0	16 7 0	35 15 0	Dr. Thorne.
Wallingford - -	8	3	—	10 2 0	12 17 0	33 17 0	„ Stevens.
Walsingham - -	6	1	—	—	—	6 9 0	„ Airy.
Wangford - - -	2	1	—	—	—	20 11 0	Do.
Ware - - - -	8	3	—	3 0 0	8 19 0	18 3 0	„ Thorne.
Watford - - -	5	1	—	—	—	12 18 0	Do.
Wayland - - -	2	—	—	—	—	—	„ Airy.
Wellington (Som.) -	6	—	1	—	—	9 11 4	„ Blaxall.
Wells - - - -	4	1	—	—	—	10 16 0	Do.
Welwyn - - -	1	—	—	—	—	—	„ Thorne.
Weobley - - -	3	1	—	—	—	3 10 0	„ Airy.
Westbury-on-Severn	4	3	—	8 18 0	28 0 0	52 2 0	„ Ballard.
West Derby - -	6	3	—	33 0 0	155 18 0	312 1 0	„ Beard.
Westminster - -	2	2	—	17 3 0	28 16 0	45 19 0	„ Stevens.
West Ward - -	4	1	—	—	—	10 10 0	Mr. Power.
Wheatenhurst - -	2	1	—	—	—	10 8 0	Dr. Ballard.
Whitchurch (Hants)	3	2	—	3 8 0	7 0 0	10 8 0	„ Stevens.
Whitechapel - -	1	1	—	—	—	104 12 0	Do.
Whitehaven - -	6	2	—	3 10 0	39 15 0	43 5 0	Mr. Power.
Wight, Isle of - -	9	6	1	5 0 0	20 3 0	76 10 4	Dr. Stevens.
Wigton - - -	7	3	—	2 9 0	9 7 0	15 11 0	Mr. Power.
Williton - - -	7	1	1	1 10 8	6 15 0	8 5 8	Dr. Blaxall.
Winchcomb - -	2	2	—	5 19 0	15 2 0	21 1 0	„ Ballard.
Winchester, New -	4	4	—	5 18 0	24 3 0	44 13 0	„ Stevens.
Windsor - - -	3	3	—	6 2 0	29 9 0	52 11 0	Do.
Wirrall - - -	4	1	—	—	—	14 0 0	„ Beard.
Woburn - - -	3	2	—	5 18 0	6 1 0	11 19 0	„ Thorne.
Wokingham - -	4	1	1	5 4 0	7 16 0	13 0 0	„ Stevens.
Woodbridge - -	4	2	—	11 10 0	13 8 0	24 18 0	„ Airy.
Worcester - - -	1	1	—	—	—	40 7 0	Mr. Power.
Worksop - - -	7	2	—	5 7 0	7 12 0	12 19 0	Dr. Beard.
Yarmouth, Great -	1	1	—	—	—	28 6 0	„ Airy.
Yeovil - - -	7	2	—	6 5 0	9 2 0	15 7 0	„ Blaxall.
York - - - -	6	1	—	—	—	3 8 0	„ Beard.
Total -	1,536	701	42	—	—	12,513 8 4	

Supplementary List of Awards made in 1876 to Public Vaccinators in Unions which were inspected in 1875.

				£ s. d.	£ s. d.	£ s. d.	
Crickhowell - -	2	1	—	—	—	12 5 0	Dr. Airy.
Goole - - - -	5	3	—	2 8 0	6 0 0	12 17 0	„ Beard,
Selby - - - -	5	2	—	0 19 0	5 3 0	6 2 0	Do.
Total -	12	6	--	—	--	31 4 0	

No. 3.

STATISTICS of the NATIONAL VACCINE ESTABLISHMENT and EDUCATIONAL VACCINATING STATIONS.

APP. No. 3.

National Vaccine Establishment.

I.—STAFF at end of 1876.

N.B.—The stations named in *italics* are Educational Vaccinating Stations, authorised by the Local Government Board.

—	Name.	Vaccinating Stations.	Days and Hours of Attendance.
Vaccinators supplying lymph for the public service, & salaried from the Parliamentary grant	1. Mr. J. F. Marson	*Surrey Chapel*	Tues., Thurs.; 1.
	2. Mr. W. E. G. Pearse	*Tottenham Court Chapel.*	Mon., Wednes.; 1.
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. Mr. Ellis S. Guest	*Manchester*	Monday; 2.
	2–5. Dr. Edmund Robinson.	*Birmingham*	2. Monday 3. Tuesday 4. Wednesday 5. Thusday 11
	6. Dr. H. A. P. Robertson	*Bristol*	Wednesday; 10.
	7. Mr. A. B. Steele	*Liverpool*	Thursday; 2.
	8. Mr. E. L. Webb	*Pimlico*	Thursday; 10.
	9. Mr. J. Hawthorn	*Newcastle-on-Tyne.*	Wednesday; 3.
	10. Mr. W. E. G. Pearse	*Westminster*	Tuesday; 2.
	11–12. Mr. W. A. Sumner	*Marylebone*	Monday Wednesday 11.
	13. Mr. C. T. Blackman	*Whitechapel*	Wednesday; 11.
	14. Mr. Frederick Holmes	*Leeds*	Tuesday; 2.30.
	15. Dr. Edward Lynes	Coventry	Tuesday; 12.
	16. Dr. Hugh Thomson	*Glasgow*	Monday; 12.
	17. Mr. C. Harriot Roper	*Exeter*	Thursday; 3.
	18. Mr. Robert W. Dunn	*Strand*	Thursday; 11.
	19. Mr. Matthew Brownfield	Bromley, Middlesex.	Tuesday; 3.
	20. Mr. John Broadbent	Ancoats	Wednesday; 2.
	21. Mr. W. Skinner	*Sheffield*	Tuesday; 3.
	22. Dr. A. C. Clarke	Salford	Thursday; 2.
	23. Mr. N. Miskin	Waterloo	Tuesday; 2.
	24. Mr. T. F. Morrish	Toxteth Park	Tuesday; 11.
Teachers of Vaccination not supplying lymph	Dr. W. Husband	*Edinburgh*	Wednes., Sat.; 12.
	Dr. R. D. Tannahill	*Glasgow*	Mond., Thurs.; 12.

II.—Sources and Amount of Lymph Supply in 1876.

N.B.—The stations named in *italics* are Educational Vaccinating Stations, authorized by the Local Government Board.

—	Vaccinating Stations.	Number of Vaccinations performed at the Stations respectively.		Number of Charges of Lymph supplied from the Stations respectively.	
		Primary.	Re-vaccinations.	Charged Ivory Points.	Charged Tubes each estimated as equal to 10 Ivory Points.
Vaccinators salaried from the Parliamentary grant -	1. *Surrey Chapel*	690	112	15,410	—
	2. *Tottenham Court Chapel.*	894	91	80*	711
		1,584	203	15,490	711
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. *Manchester* -	1,463	103	—	1,027
	2–5. *Birmingham*	5,736	63	—	3,706
	6. *Bristol* - -	675	12	—	72
	7. *Liverpool* -	1,115	25	—	815
	8. *Pimlico* - -	482	77	—	544
	9. *Newcastle-on-Tyne.*	672	—	—	990
	10. *Westminster* -	980	35	—	890
	11–12. *Marylebone*	1,525	114	—	907
	13. *Whitechapel* -	1,334	215	—	706
	14. *Leeds* - -	1,067	—	—	480
	15. Coventry -	1,012	2	—	755
	16. *Glasgow* - -	1,312	—	—	1,218
	17. *Exeter* - -	579	1	—	93
	18. *Strand* - -	526	115	—	216
	19. Bromley -	1,356	9	—	731
	20. Ancoats - -	1 393	25	—	4,029
	21. *Sheffield* - -	1,049	—	—	153
	22. Salford - -	1,032	241	—	748
	23. Waterloo -	749	25	—	1,122
	24. Toxteth Park -	1,474	331	—	1,014
	Total - -	25,531	1,393	—	20,216
	General Total -	27,115	1,596	15,490	20,927†

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* This number includes 20 charged glasses, each estimated as equal to four charged ivory points.

† At the beginning of the year there was a considerable stock of lymph on hand, and during the year additional supplies (to the extent of 685 charged tubes) were obtained from the following gentlemen :—

Mr. C. C. Claremont - - Hampstead Road.
Mr. T. L. Gentles - - - Derby.
Dr. W. V. Lyle - - - Harrow Road.
Mr. J. Speer - - - Liverpool.
Mr. E. G. Pottle - - - Saint Luke's.
Mr. J. P. Purvis - - - Greenwich.
Mr. J. F. Staines - - - Endell Street.

III.—Distribution of Lymph, 1876.

Number of applications :—	
From Medical Practitioners in England and Wales	10,382
„ „ „ Scotland	191
„ the Army	656
„ the Navy and from the Emigration Department	113
„ India and the Colonies	184
„ Diplomatic and other Foreign Services	105
Total	11,631
Supplies sent out :—	
Charged ivory points	21,750
„ squares of glass	20
„ capillary tubes	25,307

No. 4.

ABSTRACT of MEDICAL INSPECTIONS made in 1876 with regard, generally, to the INCIDENCE OF DISEASE on particular places, and to consequent Questions concerning the LOCAL SANITARY ADMINISTRATION.

Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdictions Concerned.	Chief Facts reported by Inspector.
1. Ash (Kent.) Population, 655. *Mr. Power.*	Local information	Dartford rural sanitary authority.	Severe and fatal outbreak of diphtheria at an isolated farmhouse. Very minute inquiry respecting source and method of diffusion of the disease, but without much positive result.
2. Blackwater (Hants.) Population, 800. *Dr. Stevens.*	Request of Medical Officer of Health.	Hartley Wintney rural sanitary authority.	Epidemic of scarlet fever. Insufficient provision for sanitary inspection, and absence of means of isolation of infectious diseases.
3. Brailes (Warwickshire.) Population, 1,285. *Mr. Power.*	Regis.-General's Return	Shipston-on-Stour rural sanitary authority.	Fatal prevalence of diphtheria, specially incident on children. Dissemination of the disease apparently not through schools. Unwholesome conditions in the place as regards dwellings, water supply, excrement disposal, and drainage. Want of proper means of isolation.
4. Calstock (Cornwall.) Population, 6,557. *Dr. Blaxall.*	Report of Medical Officer of Health.	Tavistock rural sanitary authority.	Deaths from diphtheria of annual occurrence. Typhoid fever endemic. with occasional outbreaks of an epidemic character. An epidemic of typhoid fever at Gunnislake in the autumn of 1875, due, probably, to specific contamination of the chief water supply. Sewerage defective; privies with open pits in general use; privy accommodation insufficient. Water supplies greatly exposed to pollution. Sanitary state of locality generally unsatisfactory.
5. Chalvey (Bucks.) *Mr. Power.*	Local request	Eton rural sanitary authority.	Outbreak of enteric fever. Cesspools and wells intermingled in porous soil. Hand-flushed closets, sinks, and slop-drains in connexion with cesspools. Excremental fouling of air, earth, and water.
6. Eagley and Bolton (Lancashire.) *Mr. Power.*	Local request	Turton local board. Bolton town council.	Simultaneous outbursts of enteric fever in Eagley and Bolton in connexion with the milk service of a particular dairy. Dairy water obtained from a brook, the course and banks of which had recently been largely fouled by human excrements. Arrangements for excrement disposal in Eagley, as well as sewerage, drainage, and water supply, deficient.
7. Gainsborough Union *Mr. Radcliffe.*	Report of the public vaccinator of the Misterton district.	Gainsborough board of guardians.	A series of cases of erysipelas, following upon vaccination, in the autumnal half-yearly vaccinations of the public vaccinator. Eighteen cases in all, 8 fatal; 14 of the cases, of which 6 fatal, occurring in the public vaccinator's work. The erysipelas, in the first instance, traumatic in nature, and concurrent with traumatic erysipelas in the district unconnected with vaccination; the disease afterwards mainly spreading by infection, the diffusion of the infection being facilitated by certain irregularities in the practice of vaccination by the public vaccinator.
8. Great Coggeshall (Essex.) Population, 3,300. *Dr. Thorne.*	Report of Medical Officer of Health.	Witham rural sanitary authority.	1. Extensive and prolonged epidemic of diphtheria. 2. Epidemic of enteric fever spread in the first instance through the agency of an infected milk supply and subsequently through the generally defective sanitary arrangements of the town.

Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdictions Concerned.	Chief Facts reported by Inspector.
9. Hanwell - - - (Middlesex.) Population, 3,768. *Dr. Thorne.*	Local complaint - -	Brentford rural sanitary authority.	Frequent prevalence of zymotic diseases, notably enteric fever, diphtheria, and epidemic diarrhœa. Contents of surface wells fouled by soakage of filth. Absence of proper means of sewerage and drainage; general nuisance from accumulation of sewage in ditches and cesspools, with escape of foul air into dwellings. Closets provided with trap and pan found choked and filthy owing to absence of proper means of flushing. Large accumulations of privy and cesspool contents.
10. Horningsham - (Wilts.) Population, 934. *Mr. Power.*	Information from local registrar.	Warminster rural sanitary authority.	Fatal prevalence of diphtheria. Sanitary circumstances of village good. Evidence respecting causation and diffusion of the disease negative in character.
11. Llanelly - - - (Brecon.) Population, 8,333. *Dr. Blaxall.*	Report of Medical Officer of Health.	Crickhowell rural sanitary authority.	Continued prevalence of typhoid fever. Epidemic of typhoid fever at Darenvellin. Insufficient privy accommodation. Unwholesome method of excrement removal. Absence of sewerage and drainage. Accumulations of refuse near dwellings. Unwholesome dwellings. Water supplies generally exposed to contamination.
12. Ludlow Registration District. (Shropshire.) Population, 18,078. *Dr. Airy.*	Regis.-General's Return	Ludlow rural sanitary authority.	*Ludlow Rural Sanitary District.*—Diphtheria epidemic in 1875–6, apparently in relation to concourse of children at school. Some of the water impure. Some privy nuisances. Some want of drainage. General sanitary administration satisfactory.
	„	Ludlow urban sanitary authority.	*Ludlow Urban Sanitary District.*—Sewers imperfectly flushed and ventilated; some badly constructed. Great nuisances from filthy privies and cesspools. Neglect of excrement removal. Nuisances from pigsties and slaughter-houses. Water supply part (good) from springs, part (bad) pumped from river, or obtained from wells in more or less danger of pollution. Filtration of sewage flowing into river imperfect. Epidemic of enteric fever in 1876, chiefly in Corve Street, in connexion with offensive ill-ventilated sewer, and defective trapping of house-drains. Want of hospital accommodation. General sanitary administration unsatisfactory.
13. Machynlleth Registration District. (Montgomeryshire.) Population, 18,317. *Dr. Airy.*	Regis.-General's Return	Machynlleth rural sanitary authority.	*Machynlleth Rural Sanitary District.*—Enteric fever long prevalent in Machynlleth. Sewers in Machynlleth imperfectly ventilated. Nuisance at outfall of sewer. Nuisances from privies and pigsties. Neglect of excrement removal. Water supply deficient, and mostly impure. Dwellings generally ill-protected from damp.
	„ „	Towyn urban sanitary authority.	*Towyn Urban Sanitary District.*—Epidemic of scarlatina throughout district in 1876. *Towyn.*—Ruinous state of some dwellings. Water supply mostly in danger of pollution. Waterclosets drained into cesspools. Some nuisances from filthy privies. Sewers imperfectly ventilated. *Aberdovey.*—Ventilation of houses defective, owing to want of space. Water supply, from hill-side, allowed to be polluted before reaching reservoir. Some nuisance from drains opening on the beach. Drains imperfectly ventilated.

Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdictions Concerned.	Chief Facts reported by Inspector.
14. Manchester, The Royal Infirmary. *Mr. Radcliffe.*	Request of a General Committee of the Trustees.	- - - -	Prevalence of erysipelas and other traumatic infections in the wards, surgical overcrowding of the wards and overcrowding of the parts of the building set apart for the accommodation of nurses and servants, imperfect drainage and excessively foul state of the drains, faulty plan and construction, and generally defective sanitary condition of the building.
15. Necton - - (Norfolk.) Population, 868. *Dr. Airy.*	Request of the General Inspector of the Board for the district.	Swaffham rural sanitary authority.	Past prevalence of fever, probably enteric. Many houses dilapidated, ill-ventilated, unprotected against damp, and overcrowded. Many wells dangerously near to privies, uncovered, and in disrepair. Water impure. Nuisances from privies, pigsties, and slops. Want of drainage in centre of village and want of means of isolation of infectious disease.
16. Penkridge - - (Staffordshire.) Population, 2,435. *Dr. Airy.*	Request of local authority.	Penkridge rural sanitary authority.	Fatal prevalence of fever in township. Houses ill-ventilated. Wells in danger of pollution from neighbouring privies and pigsties, and nuisances from both these. Sewers and drains untrapped, and without ventilation shafts. Subsoil kept saturated by river Penk, which is dammed up to feed a mill. Lower parts of town heavily flooded in 1875. Want of hospital accommodation.
17. Pontypridd Registration District. (Glamorgan.) Population, 51,921. *Dr. Airy.*	Regis.-General's Returns	- - - -	Continued prevalence of fever throughout registration district. Excessive increase of population, due to coal-mining activity. Overcrowding. High general death rate. Prevalence of phthisis.
	„ „	Pontypridd rural sanitary authority.	*Pontypridd Rural Sanitary District.*—Dwellings damp and crowded together. Drainage very bad. Filthy privies and cesspits. Imperfect removal of excrement by house owners. Water supply mostly liable to fæcal pollution. Serious outbreak of enteric fever at Heolfach. Want of infectious diseases hospital for non-paupers.
	„ „	Pontypridd urban sanitary authority.	*Pontypridd Urban Sanitary District.*—Drainage imperfect. Part of the water supply liable to pollution. Excrement retained in leaky cesspits.
	„ „	Mountain Ash urban sanitary authority.	*Mountain Ash Urban Sanitary District.*—Roof - drainage imperfect. Sewers imperfectly ventilated. Nuisances from filthy privies. Water supply satisfactory.
18. Portsmouth - Population, 113,569. *Dr. Thorne.*	Regis.-General's Returns.	Portsmouth Town Council.	Widely spread epidemic of scarlet fever. Default on the part of the sanitary authority in making any provision for the isolation of persons suffering from dangerous infectious diseases.
	„ „	- - - -	Mortality statistics for the last 26 years showing a high death rate from "all causes," and from scarlatina, also a high infantile death rate. Local insanitary conditions favouring the dissemination of disease and promoting the fatality therefrom.
19. Redruth Registration District. (Cornwall.) Population, 53,520. *Dr. Blaxall.*	„ „	Redruth rural sanitary authority.	Prevalence of scarlatina throughout the district, of "fever" and diarrhœa in the parish of Illogan, and of diphtheria in the parish of Gwinear. Total neglect of all precautionary measures to prevent the spread of disease. Want of drainage. General prevalence of slop and excremental nuisances. Insufficient amount of privy accommodation. Water supply insufficient and exposed to pollution. Dilapidated and unwholesome condition of dwellings. Overcrowding to a serious extent.

Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdictions Concerned.	Chief Facts reported by Inspector.
Redruth Registration District—*cont.*	Regis.-General's Return.	Redruth local board.	Exceedingly high mortality from scarlatina, also a high general infantile death rate. No means adopted to prevent the spread of disease. Urgent need of proper drainage, and of a more wholesome method of excrement removal. Privy accommodation insufficient. Storage of excrement in old disused wells. Insufficient water supply. Slaughter-houses in a filthy state. Lodging-houses dirty and overcrowded. Dwellings unwholesome, serious overcrowding.
	„ „	Phillack local board.	High rate of mortality, specially from zymotic disease. Diphtheria endemic. Want of proper drainage, prevalence of slop and excremental nuisances. Want of privy accommodation. Dangerous water supply. Unregistered and filthy slaughter-houses.
	„ „	Hayle local board.	Sanitary condition of the district very satisfactory, and in great contrast to adjacent district of Phillack. Measures adopted in 1870 to improve the sewerage and water supply, &c. Decrease of zymotic death rate since 1870. Absence of mortality from diphtheria, fever, and diarrhœa extending over a period of five years and nine months, 1871–76.
20. Royston Rural Sanitary District. (Herts.) Population, 19,713. *Dr. Thorne.*	Registrar-General's return, and reports of Medical Officer of Health.	Royston rural sanitary authority.	Frequent prevalence of, and large mortality from, enteric fever. Water supply in many villages very deficient and very foul. General nuisance from ill-constructed and ill-managed closets. Means of sewerage and drainage, if not altogether absent, as a rule so badly arranged as to be rather a source of nuisance and of injury to health. Dwelling accommodation in certain parts of district utterly dilapidated and filthy. General and long continued default on the part of the authority to deal with the above-named causes of disease, when brought under their notice.
21. Tideswell - - (Derbyshire.) Population, 1,905. *Dr. Thorne.*	Regis.-General's Return.	Bakewell rural sanitary authority.	Outbreak of enteric fever. Spread of disease favoured by conditions in an intermitting water service allowing of suction of foul air into water-pipes, and by defective conditions of sewerage. Closet accommodation insufficient and a source of nuisance.

No. 5.

PAPERS ON HOSPITAL HYGIÈNE.

A.

APP. No. 5.

HOSPITAL HYGIÈNE.

On Erysipelas in the Radcliffe Infirmary, Oxford, 1874–5, by Mr. Netten Radcliffe.

REPORT by Mr. NETTEN RADCLIFFE on RECENT PREVALENCE of ERYSIPELAS in the RADCLIFFE INFIRMARY, OXFORD (1874–5).*

Subject of inquiry.

This inquiry was directed to ascertain the conditions under which erysipelas had been produced in a series of cases under treatment in the Infirmary during the summer and autumn months, and beginning of the winter, of 1874. The first attack of erysipelas occurred on the 10th June, the last included in this inquiry on the 9th December. Within this period 26 cases, admitted into the Infirmary for other forms of disease or for injuries, had been attacked with erysipelas, and five of these cases had died in consequence of the superinduced malady. With three exceptions, all the cases attacked were surgical cases ; and of the three exceptions, two had required surgical interference, and the third had contracted erysipelas in a surgical ward, to which the patient had been removed from a medical ward while the latter was being cleansed. The erysipelas which had been prevalent in the Infirmary during the period under consideration, had, in fact, been that form of the disease which has been designated "traumatic," and which, when it shows itself in successive cases in hospital wards, is held to be one of the most significant indications of their unhealthiness or mismanagement.

I append a tabulated statement (Table A) of the different cases attacked with erysipelas, and of such other cases (two of erysipelas admitted into the hospital, and one of diffuse cellulitis) as I shall have to refer to in the course of this report.

Traumatic Erysipelas.

Traumatic Erysipelas.—It may be serviceable to preface further details by a brief account of traumatic erysipelas in its relation to hospital hygiene, and for this purpose I prefer to quote certain observations on the subject by the Medical Officer of the Privy Council and Local Government Board, Mr. John Simon. He writes :—

> "In ill-kept hospitals wounds go on badly. Instead of running their normal course of repair and recovery, they—whether accidental wounds, or wounds made by operative surgery—undergo certain characteristic morbid changes. Erysipelas will frequently attack them. So will other morbid processes akin to erysipelas—such morbid processes as those of gangrene and phagedæna, and putrefactions of effused and otherwise stagnant blood, and re-opening of half-healed arteries and veins, and septic and suppurative infections of the system, and so forth : morbid processes, which,

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* The inquiry to which this Report refers was undertaken, during a period of vacation, at the request of the Committee of Management of the Radcliffe Infirmary. The Report was therefore addressed to the Committee ; but I have (as already explained) thought it desirable to reproduce it here in conjunction with other Reports relating to Hospital Hygiene.—E. C. S.

Showing C IRMARY, OXFORD, in 1874, to the 12th December.

No.	Date of Admission.	Isolation.		Result.	Remarks.
		Di od, and Name of lation Ward.	Not Isolated.		
1	*April 24* -	*J Bagot* - -	- -	Recovered	Much subcutaneous sloughing.
2	May 27 -	Ju - -	- -	*Died* -	Not isolated until day of death.
3	April 15 -	Ju - -	Not -	Recovered	Amputation, May 14th. Severe case.
4	June 30 -	Au Old Fever Block	- -	Do. -	
5	June 17 -	Jul - -	Not -	Do. -	
6	July 1 -	Au - -	Not -	Do. -	
7	March 31-	Au Old Fever Block	- -	Do. -	Severe case.
8	July 22 -	Au - -	Not -	*Died* -	
9	July 16 -	Au - -	Not -	*Died* -	
10	July 22 -	Oct - -	Not -	Recovered	
11	July 30 -	Sep Old Fever Block	- -	Do. -	
12	Aug. 14 -	Au - -	Not -	*Died* -	
13	July 9 -	Oct Old Fever Block	- -	Recovered	
14	Aug. 19 -	Oct New Fever Block	- -	Do. -	Severe case.
15	Sept. 5 -	Oct - -	Not -	Do. -	Do.
16	Sept. 2 -	Oct - -	Not -	Do. -	Do.
17	Aug. 25 -	Sep New Fever Block	- -	Do. -	
18	Sept. 9 -	Oct - - -	- -	Do. -	Tumour removed. Erysipelas very severe.
19	Sept. 2 -	Oct. -	Not -	Do. -	Amputation Very severe case.
20	*Sept.* 21 -	*Oct.* - -	- -	*Died* -	
21	*Sept.* 30 -	*Nov* - -	- -	Recovered	
22	Sept. 19 -	Nov. - -	- -	Do. -	
23	Sept. 1 -	Nov - -	- -	Do. -	
24	July 1 -	Dec. - -	Not -	Relieved -	
25	Oct. 17 -	Dec. ew Fever block	- -	Recovered	
26	Oct. 2	Jan. - -	- -	Relieved -	
27	Nov. 11	Dec. - -	- -	Do.	
28	Nov. 25 -	Jan. -	- -	Recovered	Severe, face.
29	Dec. 3 -	Jan. - -	- -	Do.	Severe, head.

APP. NO. 5.

HOSPITAL HYGIÈNE.

On Erysipelas in the Radcliffe Infirmary, Oxford, 1874-5, by Mr. Netten Radcliffe.

Traumatic Erysipelas.

with erysipelas, may, for my present purpose, conveniently be generalized under the one name of traumatic infections. . . . . Traumatic erysipelas is a true zymotic disease,*—a disease in which the affected materials of the body furnish a specific contagium. On but too many occasions the contagiousness of the disease has been convincingly and fatally proved;—enough, perhaps, had there been only such evidence as is adduced from hospital surgery; but still more by evidence, again and again given, that a surgeon, going to a puerperal woman from attendance on a case of erysipelas, may convey the specific contagion to the uterine surface of his new patient, and occasion death by that form of puerperal fever which, under a special name, is in fact but intra-abdominal erysipelas. But to say that the disease is contagious, is not to say that no case of it can arise without contagion from a previous case. Indeed, in this respect erysipelas has a peculiar place among the zymotic diseases. Probably of all the specific contagia, the contagium of erysipelas stands in nearest affinity to the ferments of common cadaveric decomposition, and is, therefore, aptest to arise *de novo* whenever certain animal textures and juices, or the effluvia from such textures and juices are falling into common putridity. Immense mortality from puerperal fever in one division of the Vienna Lying-in Hospital, varying from about a fourth to about a ninth part of all the deliveries which took place there, was believed by Dr. Semelweiss, the head of the department, to depend on an infection of which 'the real *source was to be found in the hands of the medical men in attendance, contaminated with cadaveric poison.*' The other division of the hospital (reserved for the practical instruction of midwives, whose training does not require them to be brought into contact with dead bodies) suffered only about a tenth part as much as the first; and this was the more noticeable as the second division was inferior to the first in the size and airiness of its wards. Dr. Semelweiss, acting upon his supposition as to the cause of the disease, required that the male attendants of the first division should, as much as possible, avoid contact with cadaveric matter; that after such contact they should never make a vaginal examination till the following day; and that, besides very thoroughly cleansing their hands, they should systematically *disinfect them with a solution of chlorine.* The latter precaution was not introduced till some months after the more general precautions had been adopted. The result of these measures was, that the mortality of the first division at once fell to the usual average of the second division. In 1846 the death-rate per cent. had been 13⅔; in 1847 it was 5⅓; in 1848 it was 1⅓. And the relation of this fact to the possible 'spontaneous generation' of erysipelas contagium is not, I think, far to seek. For any wound in the unhealthy state which is technically called 'foul,' is, in fact, a surface of decaying animal matter; that which surgeons call a 'slough,' or 'mortified part,' is a dead bit of the animal body undergoing just such putrefactive changes as it might undergo in the dissecting room; and, accordingly, if cadaveric decomposition can easily furnish the contagium of erysipelas, every surgical ward of an active hospital must (in respect of the natural processes of disease going on in it) be a likely birthplace for that contagium. Thus, for instance, if a patient has been admitted with a contused wound of such severity as involves local mortification, that mortification would include in itself an essential liability to the formation of erysipelas contagium. Whether the contagium, if thus engendered, produces in that particular patient the spreading surface-inflammation which characterizes erysipelas, may depend on his personal susceptibility, and especially, no doubt, on the then-existing chemical state of his live textures next adjoining the wound; but whether his general mass of body be or be not infected by the specific contagium which has been engendered in his wound, in any case contagium would be set free, and would act on the atmosphere of the ward. Its influence in this atmosphere would be determined by circumstances: if the ward were well ventilated, dilution or oxydation would probably have rendered the contagium inert before it had travelled far from its source; but if, on the other hand, the ward were ill-ventilated, either absolutely, or in proportion to its contained quantity of ill-conditioned surgical cases, then, probably, the unclean atmosphere would abound with the material which the contagium could convert into its own likeness; and such an atmosphere, continuous through the whole length of the ward, and perhaps receiving increments of new-formed contagium from other beds than the first, would be so very dangerous an influence to even the best-conditioned wounds, that probably there would be in the ward what is called an 'epidemic' of erysipelas; and, in addition to the danger that the contagion might thus by continuity of atmosphere spread from one patient to others, there is also danger, except with the cleanliest and most careful nursing, that attendants will convey it from one part of the ward to another in the successive wound-dressings which they perform." †

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* "This is equally true of the non-traumatic erysipelas, the pathology of which disease, however, needs not here be particularly discussed."

† Sixth Report of the Medical Officer of the Privy Council, 1864, pp. 59 and 60.

App. No. 5.

HOSPITAL HYGIÈNE.

On Erysipelas in the Radcliffe Infirmary, Oxford, 1874-5, by Mr. Netten Radcliffe.

Previous prevalence of Erysipelas in Infirmary.

Previous Prevalence of Erysipelas in the Infirmary.—In attempting to elucidate the causes of the recent prevalence of erysipelas in the Infirmary, it is important to ascertain the ordinary history of the wards with reference to this disease. Unfortunately, no record has been kept of the different maladies which are liable to originate in hospitals, the so-called traumatic infections, namely, erysipelas, diffuse cellulitis, softening of clot, pyæmia, gangrene, and phagedæna.* It has been impracticable, therefore, to determine with such precision as was desirable, and which should have been possible, the usual state of the wards with reference to these diseases. It would appear, however, to be certain that, for the past 25 years, there has been no such considerable prevalence of erysipelas in the Infirmary as that which forms the subject of the present inquiry. During the four years 1847–50, erysipelas was so seriously prevalent in the wards, that 28 deaths were occasioned by the disease among the patients. Of these deaths 12 took place in 1847, the year in which the prevalence began. In this year it is to be inferred that erysipelas was widely diffused also in the district from which patients are sent to the Infirmary, for eight cases of erysipelas were admitted into the wards—the largest number of admissions for this disease recorded from 1837 to the present time. The great prevalence of erysipelas which began in the Infirmary in 1847 was indeed, very probably, part of a more general outbreak affecting the surrounding district; but while the disease would appear, judging from the admissions, to have rapidly diminished outside the building, it persisted with much severity in the wards until 1850. For the admissions of cases of erysipelas into the Infirmary, which in 1847 had numbered 8, in 1848 fell to 1, none taking place in the two subsequent years 1849–50. But the deaths from erysipelas in the Infirmary, which in 1847 had been 12, in 1848 were 5; in 1849, 6; and in 1850, 5. In 1851, no death from erysipelas occurred.†

This protracted and very fatal prevalence of erysipelas in the Infirmary was connected with an uncleanly condition of the wards, particularly filthy beds, with insufficient ward-space and defective ward arrangements, the latter especially impeding ventilation, and with very imperfect drainage. After the uncleanly condition of the wards had been removed, and the defective drainage and ventilation largely amended, erysipelas does not appear again to have originated or spread to any considerable extent in the Infirmary until the recent prevalence.

It would have been instructive to compare the occurrences of erysipelas and other traumatic infections in the wards, with the successive improvements which have been effected in their sanitary arrangements, but, as already stated, data do not exist for the purpose. From want of these data, moreover, it is impossible to estimate as clearly as could be wished the respective influence exercised by the several conditions which appear to have co-operated in determining the recent prevalence of erysipelas. It is stated to me that during the period from 1851 to 1874, instances of traumatic infections had not been of unfrequent occurrence, although they had shown little tendency to multiply, and, in fact, had not multiplied until the year just past. In 1873, for which year I have recovered

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* In thus placing together the various names under which hospital infections may be recorded, I would not be held to express any judgment on the pathology of the disease that is known as pyæmia. It is enough for my present purpose that some forms of the disease thus designated are of a nature cognate to erysipelas.

† I am indebted to Mr. Briscoe for the number of deaths caused by erysipelas in the Infirmary during the several years 1847–50.

Previous prevalence of Erysipelas in Infirmary.

some of the facts as to such infections, there seem to have occurred in the Infirmary 5 cases of erysipelas (2 in the Marlborough Ward, of which 1 was fatal, and 3 in the Accident Ward), and 3 cases of pyæmia, all fatal, in the Marlborough Ward. These occurrences suggest either that there were some growing conditions of unwholesomeness in the Infirmary which culminated in 1874, or that the liability to traumatic infections in the wards had in past years been greater than has been considered. In the absence of positive data, an opinion must be formed on this question from an examination of the conditions which would promote such liability, and these, as will subsequently be shown, lead to the inference that neither alternative can, perhaps, be wholly rejected.

The instances of traumatic infections in 1873 have an important bearing upon the early history of the recent prevalence of erysipelas, which I now proceed to consider.

Prevalence of Erysipelas, 1874.

Prevalence of Erysipelas, 1874.—The patient first attacked with erysipelas in 1874 was a little boy named Jesse Hill, three years old, who had been admitted into the Accident Ward, from Summertown, on the 27th May, with a severe scalp wound. Erysipelas appeared on the 10th June, fourteen days after the admission of the case, and on the 21st June the boy died from its effects, he lying then in the Bagot Ward, to which he had been removed that day.

This was the first case of the series which forms the subject of inquiry, and it formed the starting-point of that exceptional diffusiveness which characterized the subsequent progress of erysipelas in the wards. In view of this peculiar diffusiveness it became necessary to determine, if that were possible, in what respect this case had differed in its origin from the cases occurring in the wards in 1873 and in preceding years, which had exhibited no such tendency. Or, in other words, to ascertain why traumatic erysipelas, which for some time had given rise to no great anxiety in the Infirmary, should in 1874—the hygienic condition and management of the wards being apparently the same—have become a formidable and fatal malady. One highly important consideration suggested itself at once. At the time when Hill was admitted into the Infirmary, erysipelas was present in several parts of Oxford, and had begun to assume an epidemic character. Hill's case concurred, in fact, with the early indications of epidemic diffusiveness of erysipelas in the city, and it was not improbable that the infection of the disease, under circumstances favouring its diffusion, might have been introduced into the Infirmary from without. Careful inquiry has failed to discover sufficient grounds for the belief that such introduction took place, and, although it is difficult to exclude all the possibilities of conveyance of so subtle an infection as that of erysipelas, I am of opinion that the explanation of the origin of Hill's case and of the peculiar diffusiveness of the erysipelas of which it was an example, is to be sought in another direction.*

Failing infection from without, there can be little if any doubt, that erysipelas in Hill's case originated from the operation of similar conditions to those which gave rise to the cases of erysipelas and pyæmia in the preceding year. The concurrence of this case, and of succeeding cases, with epidemic erysipelas in the city, suggests that the difference in diffusive quality of the erysipelas observed in 1874, as compared with 1873 and several previous years, was probably a result of the co-

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[* Later information has led me to suspect that Hill received the infection of erysipelas from a case in the city.—J. N. R.]

operation of the local conditions favourable to erysipelas in the Infirmary, with the more general conditions which had conduced to the epidemic prevalence of the disease in the city;—that, indeed, the Infirmary, in a way to be discussed hereafter, was in 1874 exposed to the combined influence of the conditions which were operative in producing erysipelas in its neighbourhood and of certain conditions operative to the same end existing in its wards.

Prevalence of Erysipelas, 1874.

The progress of erysipelas in the Infirmary, after Hill's case, may be explained either by some special circumstances favouring communication of the disease from case to case by contagion, or from an augmented susceptibility of the patients to infection from it.* An examination of the different cases which have occurred, in their order of succession and relationship, indicates that contagion played an important part in the dissemination of the disease in the wards; but the inquiry has not disclosed any grounds for believing that the opportunities for transmission by contagion from case to case were greater during the recent prevalence of erysipelas than they had been during the period when the disease had not shown such diffusiveness. On the other hand, as this report will show, conditions of the wards existed at the time which would render surgical patients treated in them very liable to the development and diffusion of erysipelas.

Order and Relationship of Cases.

Order of Succession and Relationship of Cases.—The first case (1), *Jesse Hill* (Accident Ward), has already been discussed. The second case (2), *Edwin Slade*, was admitted from Banbury into the North Attic on the 15th April, with disease of the bones of the foot. The foot was removed by amputation of the leg on the 14th May. On the 19th June erysipelas appeared on the buttock in an aggravated form, and was followed by a large abscess there. At that time Jesse Hill had been lying ill from erysipelas nine days in the Accident Ward. Both cases were under the care of the same surgeon, and were also attended to by the house-surgeon, and it is more probable that the contagion of erysipelas had, in some way, been carried from Hill and communicated to the unhealed stump of Slade, than that it arose from any general condition of the wards. The third case (3), *Charles Kilby*, was admitted from Oxford, on the 30th June, into the Accident Ward, with compound fracture of a leg, and a scalp wound. On the 2nd July, in consequence of being noisy and troublesome, he was removed into the Bagot Ward, where there was a patient (*Frederick Fuller*) suffering from diffuse cellulitis at the time, and where Jesse Hill had died ten days before. This ward is practically a part of the Accident Ward, the nurses of the last-named ward attending the cases in the Bagot Ward. On the 7th July erysipelas appeared in the scalp wound, and subsequently it attacked the wounded leg. Kilby had been exposed for a short time in the Accident Ward to the same general ward conditions that Hill had been exposed to before contracting erysipelas. He had then been removed to the ward where Hill had died, and where Fuller was lying. This last-named case had been admitted from Lyford, Berks, into the Accident Ward, with compound fracture of a leg, on the 24th April, and four days afterwards (the 28th) the injured limb was attacked with

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[* In the first draft of this Report I also wrote, "or from an increased virulence of the infection." I struck out the phrase, doubting at the time whether the assumption it involved was quite justified in the then state of our knowledge. On reconsideration, however, particularly guided by Professor Burdon Sanderson's researches on infective inflammations, I now think that the phrase should have been retained.—J. N. R.]

Order and Relationship of Cases.

diffuse cellulitis, which subsequently spread to the trunk, and caused much destruction and sloughing of tissue. The patient was a confirmed drunkard, and the cellulitis probably resulted from the unhealthy condition he was in at the time of the accident, owing to his intemperance. Diffuse cellulitis is now commonly included among the traumatic infections, but this case does not appear to have exercised any certain influence upon the origin of erysipelas in Hill's case. Fuller, before the admission of Hill, had been removed to the Bagot Ward. Here Hill had been placed several hours before death, and here Kilby was also placed. In this ward Kilby was exposed to danger from probable retention of the contagion of erysipelas in the ward, and from liability to infection of his wounds in consequence of sharing the same atmosphere and the same attendants with the case of diffuse cellulitis. The likelihood that Kilby contracted erysipelas by contagion from one or other of the sources mentioned is so great, that, without ignoring other possible exciting or co-operating causes presently to be described, the disease is most reasonably assigned to this source. Kilby was a patient of the same surgeon (Mr. Symonds) who had had under care Hill and Slade (Slade having been discharged cured the 1st July). He was removed the day of appearance of the erysipelas to the "Old Fever Block," and there isolated.

The next case (the fourth) which happened (4), *James Cox*, was admitted with urinary disease into the Rowney (medical) Ward, under the care of Dr. Gray, on the 17th June. Catheterism was necessary, and the house-surgeon passed a catheter daily. On the 9th July, erysipelas appeared in the penis. The first explanation which presents itself to the mind of this occurrence of erysipelas (having regard to previous occurrences in the Infirmary, and the circumstances under which they had happened,) is the probability of its having arisen from inoculation; but there are other considerations which suggest a different explanation.

The fifth case (5), *George Thame*, was admitted from Abingdon into the North Attic, on the 1st July, with an abscess in the abdominal wall, under the care of Mr. Hussey. This abscess was opened (date not recorded), and on the 11th July erysipelas appeared. The sixth case (6), William Collett, was admitted (from Appleford) into the Accident Ward, on the 31st March, with compound fracture of a leg. An abscess formed on the face, and this being opened erysipelas appeared (11th July) around the incision.

The four cases last mentioned (Kilby, Cox, Thame, and Collett) all occurred in different parts of the Infirmary during the five days from the 7th to the 11th July inclusive. The quick succession of the cases, and in two, the contemporaneous occurrence, suggest the question whether they may not have arisen from some general unwholesome state of the wards, concurring with the attacks, rather than from successive infections.

It will be observed that when Kilby was attacked, on the 7th July, in the Bagot Ward, there had been no case of erysipelas in that ward since the 21st June, and no case in the Infirmary for six days; that the case of Cox followed so rapidly upon the case of Kilby as almost to exclude contagion from that source; and that the cases of Thame and Collett occurred on the same day (the 11th July). On the other hand, Thame was admitted to the North Attic on the day when Slade (the second case in the series) was discharged; and Collett was exposed to most of the dangers of infection to which Kilby had been exposed. All the cases, indeed, were exposed to very defined chances of infection, but their almost contemporaneous occurrence, and the break of sixteen days between the cases which preceded them, and of sixteen days also between

Order and Relationship of Cases.

the cases which succeeded, suggest that each may have been an indication of an unwholesome condition of the wards, apt to engender erysipelas in surgical cases, and which was known to have existed in the Accident Ward. It will subsequently be seen that such a condition of the wards must have existed at the time; but it is impossible to state the respective parts played by this condition and by infection in the development of the different cases of erysipelas.

The seventh case (7), *Charlotte Dix*, was admitted (from Oxford) into the Litchfield Ward with hæmorrhoids on the 22nd July. At that time there was a case of erysipelas (Thame) in the North Attic, and two others (Kilby and Collett) in the Old Fever Block. On the 27th July, no operation having been performed, Dix was attacked with erysipelas, from which she died. Whether the attack arose from infection or from some unwholesome condition of the ward, each being probable, cannot be said.

The eighth case (8), *James Sheppard*, was admitted (from Stanton Harcourt) into the Accident Ward, on the 16th July, with fractured thigh bone, under Mr. Briscoe. On the 3rd August erysipelas appeared in the face, indicating general infection of the ward. At this time *Dix* was ill of erysipelas in the Marlborough Ward, and the two cases already mentioned were lying in the Old Fever Block. Sheppard died on the 15th August. He was not removed from the Accident Ward. The ninth case (9), *Mark White* was admitted into the Marlborough Ward with abscess of leg, on the 22nd July, under Mr. Hussey. On the 30th July he was transferred to the Accident Ward, Sheppard lying there at the time, and on the 4th August he was attacked with erysipelas. He also was not removed. The tenth case (10), *Ann Floyd*, was admitted (from Oxford) with abrasion of the knee, into the Marlborough Ward, where Dix was lying ill, on the 30th July, and was attacked with erysipelas on the 10th August. She was removed to the Old Fever Block. The eleventh case (11), *William Day*, was admitted (from Oxford) on the 14th August with severe contused and lacerated thigh into the Accident Ward, under Mr. Hussey's care. White (9) and Sheppard (8) were then lying there affected with erysipelas. On the 18th August Day was attacked with erysipelas. He also was treated in the ward. The twelfth case (12), *Sarah Smith*, was admitted (from Stonefield) on the 9th July into the Litchfield Ward, under the care of Mr. Symonds, with a fracture into the ankle joint. A portion of dead bone was removed (date not recorded), and she was attacked with erysipelas on the 30th August. Dix (7) had been attacked with erysipelas in the Litchfield Ward on the 27th July, and had died there on the 13th August. Both cases had been removed into the Marlborough Ward from the 30th July to the 11th August, during which time the Litchfield Ward was cleansed throughout. On the day preceding the removal of the two cases back to the Litchfield Ward (the 10th August), Floyd (10) had been attacked with erysipelas in the Marlborough Ward. Floyd and Smith were both removed to the Old Fever Block. The thirteenth case (13), *James Castle*, was admitted on the 19th August with bronchitis into the Rowney (a medical) Ward. On the 25th August, the Rowney Ward being vacated for cleansing, he was removed to the Marlborough (a surgical) Ward. There Floyd (10) had been attacked with erysipelas on the 10th August, and Dix (7) had lain ill with erysipelas from the 30th July to the 11th August. Castle was attacked with erysipelas on the 31st August. He was removed to the New Fever Block.

The next two cases (the 14th and 15th) occurred in the North Attic, under the following circumstances:—*James Jackson* (14) was admitted

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(from Whichwood) into this ward, with suppuration in the palm of the hand, on the 5th September. He was the first patient received into it after the annual cleansing, two cases of erysipelas having occurred in the ward before that process, namely, one in June (Slade, 2), and one in July (Thame, 5), the latter case having been discharged on the 12th August. Jackson was attacked with erysipelas on the 8th September. On the 2nd September (15), *Henry Freeman*, the fifteenth case of the series, was admitted (from Ilford) with a diseased finger into the same ward. He occupied a bed nearly opposite to that occupied by Jackson, and was attended by the same nurse. On the 14th September he was attacked with erysipelas. Both these cases were severe, and both were treated in the ward.

The sixteenth case (16), *William Sanders*, was admitted (from North Merton) with fracture (Colles) of both arms into the Accident Ward, on the 25th August, under Mr. Symonds. White (9), attacked with erysipelas on 4th August, was a patient in the ward at the time, and Day (11), another case of erysipelas in the ward, had died there on the 20th August. Sanders was attacked with erysipelas on the 14th September, and was removed to the New Fever Block. The seventeenth case (17), *Thomas Norris*, was admitted (from Wolverton) with a tumour on the cheek, into the West Attic, under Mr. Symonds on the 9th September. He was one of the earliest cases received into the ward after its annual cleansing. On the 8th September, Jackson (14), had been attacked with severe erysipelas, in the North Attic (same floor); and on the 14th, Freeman (15), had also been attacked severely in the same attic. The tumour was removed from Norris's cheek on the 13th September, and on the 16th erysipelas appeared in a very aggravated form. The case was removed to the New Fever Block. The eighteenth case (18), *Matilda Constable*, was admitted (from Whitney) with disease of foot into the South Attic, on the 2nd September, under Mr. Hussey's care. On the 18th September the leg was amputated. At this time there were two cases of severe erysipelas on the same floor, namely, Jackson (14), and Freeman (15), in the North Attic, and another severe case, Norris (17), had been removed on the 16th from the West Attic. On the 20th September erysipelas appeared in Constable's stump, and afterwards spread extensively over the trunk and down the opposite leg. The attack was a very severe one. The nineteenth case (19), *Frederick Crozier*, was admitted (from Oxford) with empyæma into the lower ward of the New Fever Block, on the 19th September, under Dr. Tuckwell, there being two cases of erysipelas in the ward at the time. The chest was tapped the same day, and seven days afterwards erysipelas appeared in the wound and spread to the back. The twentieth case (20), *Sarah Grisfield*, was admitted (from Oxford) into the upper ward of the New Fever Block, on the 1st September, with an abscess following erysipelas, from which she had suffered at home. This abscess was opened, and one month afterwards, when she was convalescent but before the aperture had quite closed, erysipelas appeared in the incision, and she had another attack of the disease. She was attended to by the nurse who had charge of the cases of erysipelas in the lower ward.

The remaining cases, 21–26, need only be briefly referred to. Any attempt to unravel the respective influence of direct contagion, infected wards, or general sanitary state of the Infirmary or of the several wards, at this period of the prevalence would be hopeless. (21), *James Castle* who had been a patient in the Marlborough Ward, in August and September, and had then suffered severely from erysipelas, was again admitted and placed in the Rowney Ward with abscess in the neck on the 17th October, and was a second time attacked with erysipelas on the 22nd

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November. (22), *Thomas Bolter*, admitted (from Chipping Norton) to the same ward, on the 21st October, with caries of femur and tibia, was attacked with erysipelas on the 25th November. (23), *George Young*, admitted (from Oxford) also to the same ward, with caries of phalanges, on the 11th November, was attacked with erysipelas on the 27th. (24), *Charles Cooper*, admitted (from Headington) to the Accident Ward, with injury to ankle, on the 25th November was attacked with erysipelas of the face on the 1st December. (28), *Thomas Edwards*, admitted (from Oxford) to the North Attic, with thecal abscess and œdema of arm, on the 3rd December, was attacked with erysipelas, affecting the head, on the 9th. Both the last-named cases were severe.

The foregoing cases do not include all the cases of erysipelas treated in the Infirmary at the time of the prevalence. Two cases (*Walter Rogers* and *William Chapman*) were admitted, from the city, late in September, three months after erysipelas had become prevalent in the wards. Both were placed in the New Fever Block, and this brief reference to them is all that is required, so far as the present inquiry is concerned. I have excluded from consideration a case (*John L. Dixon*) described as "mild fugitive erysipelas."

Distribution of Cases in Infirmary.

The attacks of erysipelas occurring in the different wards, to December 9th, were in the numbers following:—

Accident - - - -	8
Bagot - - - -	1
North Attic - - -	5
West Attic - - -	1
South Attic - - -	1
Rowney - - - -	4
Marlborough - - -	2
Litchfield - - -	2
New Fever Block - - -	2

Sources of prevalence.

Sources of Prevalence.—Reviewing the facts and inferences which have been stated, the conclusions at which I have arrived as to the sources of the recent prevalence of erysipelas in the Infirmary are:—

(1.) That it originated in certain unwholesome conditions, partly peculiar to the wards and partly common to the Infirmary and the city; and

(2.) That the extension of the disease within the building was largely the result of its propagation by contagion.

(a) Peculiar to Accident Ward.

The conditions peculiar to the wards which might have been operative in causing the prevalence were first subjected to examination, and especially the state of the Accident Ward, in which erysipelas had first appeared, and where the disease had most frequently occurred. The infection of this ward, I may be permitted to state, was to me an especial inducement to undertake this investigation, and for the following reasons:—

The Accident Ward was one of the earliest buildings, constructed on the pavilion system, opened for hospital use in England. Except in a few minor particulars it is a model of hospital construction, and in several details unrivalled. The infection of this ward with erysipelas was a circumstance which apparently rendered doubtful some of the principles of hospital construction which were held to be most certainly settled, and an investigation of the conditions under which such infection had happened promised results of wider interest than the immediate object for which the inquiry had been instituted. I have not been disappointed in the anticipation I had formed, and the facts I am about to relate appear to me fully to account for that unwholesomeness of the ward of which the erysipelas has been one indication, and to remove all suspicion of any error in its principles of construction.

Sources of Prevalence.

Accident Ward.

It is well to observe, however, before proceeding further, that a surgical ward, devoted particularly to the reception of accidents, notwithstanding excellency of construction, can hardly escape long without cases of erysipelas or other form of traumatic infection occurring in it; for there are certain kinds of accidents which are apt, under individual states of health, to be followed by erysipelatous or pyæmic mischief. Occasional cases of this kind do not necessarily indicate any unwholesome state or defective management of a ward. On the other hand, the concurrence of several cases is a clear indication that the one condition or the other* probably exists.

It may happen that a ward will contain, at the same time, several cases of grave, suppurating injuries, each contributing largely to pollution of its atmosphere, and together fouling it to a most injurious extent. The accumulation in the same ward of injuries of the kind referred to, while the ordinary bed-space, and the number of patients received into it, remain unaltered, is a fertile source of traumatic infection. Part of the present inquiry was directed to ascertain whether there had been any unusual number of cases of this kind in the Accident Ward at the time when Jesse Hill was attacked with erysipelas. The register shows that during the months of April and May 1874, in addition to three compound fractures (two of long bones and one of the lower jaw), a larger number of severe lacerated wounds had been admitted into the ward than in the corresponding periods of the four preceding years.† I should have inferred from examination of the register that ward-fouling, from the character of the cases treated in it at the time of and immediately preceding the appearance of erysipelas, was not improbable; but the surgical staff are of opinion that no exceptional condition of the ward arose from these cases.

The conditions which have chiefly co-operated in producing the unwholesome condition of the Accident Ward under consideration have all acted by fouling its atmosphere in certain ways. The several conditions to which I refer are as follows:—

1. The position of the laundry, closely adjoining the south face of the Accident Ward and its approaches must exercise a harmful influence upon the atmosphere of the ward. When the south windows of this ward, as is very commonly the case, are freely open, the atmosphere of the ward becomes practically part of the atmosphere immediately surrounding the laundry. The amount of moisture passing into the air around the laundry, when washing is in progress, and, consequently, passing more or less into the ward also, would alone make the contiguity objectionable; for a moist atmosphere tends to foster the

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* "It ought to be accepted as an axiom in hospital management, that any *concurrence of cases* of traumatic infection originating within the hospital, or any spreading of febrile or other contagion to even a single *patient* within the hospital, is conclusive reason for inquiring whether the fundamental difficulty of hospital management has not here been unskilfully met." The fundamental difficulty here referred to is "the difficulty of providing that throughout the whole of a really active hospital the means of cleanliness, and foremost, the means of ventilation, shall be proportionate to the many special sources of foul and infective material."—*J. Simon, Sixth Report of Medical Officer of Privy Council* (1863), pp. 53 and 65.

† The cases of lacerated wounds were nine in number, and the parts lacerated were the thigh, the buttock (2), the scalp (2), the knee (2), the wrist, and the fingers.

development of erysipelas in wounds. But the moisture given off from a laundry is largely laden with organic filth from the fouled linen. In ordinary laundry processes no provision is made for the application of boiling heat at the same moment of time, to all portions of the materials washed and so destroying the adherent organic filth ; as a consequence, much of this filth, exposed to a less degree of heat than the boiling point, is carried off with evaporation, and diffused in the atmosphere. Hence a very special danger to a surgical ward contiguous to a laundry.

Sources of Prevalence.

Accident Ward.

The contiguity of the drying-ground of the laundry to the west windows of the Accident Ward is also objectionable.

2. At the western extremity of the laundry, directly beneath the windows of the Accident Ward, all the ashes of the Infirmary, and such dry house refuse as is mingled with them, are screened, and when this process is being carried out, a considerable amount of the fine dust which arises during the operation must necessarily find its way into the ward. Probably few facts have been more clearly established than the mischievous influence upon injuries of an atmosphere charged with the effluvia or the dust of mixed ashes and house-refuse.*

3. The drains of the lavatories, closets, and slop-sink of the Accident Ward have been cut off from direct communication with the principal drains of the Infirmary, so as to obviate any risk of sewer air passing back through them into the ward; but no such precaution has been taken with the drains of the nurses' scullery and watercloset in the corridor of the ward. These latter drains communicate with a drain which runs along the south sides of the Out-patients' Hall and Accident Ward (see *Plan*), and which receives the drainage of the waterclosets and urinals of the Out-Patients' Hall, of the post-mortem room, of the laundry, with its watercloset, and, as already stated, of the nurses' scullery and watercloset, attached to the Accident Ward. This drain, throughout its whole extent, is not provided with any means of ventilation or of flushing, and such offensive gases as may form in it (and having regard to the use to which it is put must almost necessarily form) will diffuse inside the walls of the buildings through the traps of the different waterclosets and sinks, or through the junctions of the pipes, into the adjacent soil. Moreover, the frequent passage of hot water into the drain, beneath the point of entrance of the various watercloset drains, must tend to force the traps by the sudden expansions of the sewer air they will cause, and otherwise to facilitate the exit of air from the drain. Such a state of the principal drain in the immediate

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* In illustration of this point the following may be quoted. "The atmosphere " may be vitiated by causes so slight as to escape observation, and yet be abundantly " productive of erysipelas. An instructive example of this was seen in one of the " male accident wards of the Middlesex Hospital, a few years ago. It was observed " that erysipelas commonly attacked the patients in two beds in particular, while it " did not occur in any other patient in the ward, or in the hospital generally. The " constant repetition of this occurrence led to the conclusion that some special cause " of vitiation of the atmosphere was in operation in the neighbourhood of these beds, " and it appeared probable that the presence of a dustbin in the area below the " window, on each side of which they were placed, must have had to do with the " phenomenon. The dust-bin was cleaned and whitewashed, its door was kept " closed, and directions were given that the window should not be allowed to remain " open. The erysipelas at once disappeared. A couple of years afterwards the disease " was again found to attack the patients in the same beds. It appeared that the " precautions had been neglected, the dust bin had again become foul, and the door " had been allowed to remain open. The adoption of the same measures again " rendered the beds healthy, and they have since remained so. It may be remarked, " that no unpleasant effluvium was detected in the neighbourhood of the window " which could lead to the impression that the atmosphere was in any way tainted."— Mr. Campbell de Morgan: art. *Erysipelas*, *Holmes's System of Surgery*, vol. i. p. 229.

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Sources of Prevalence.

Accident Ward.

vicinity of the Accident Ward, and connected with some of its offices, is certainly most undesirable, and may very probably have contributed, by the occasional overflow of sewer air into the corridor of the ward, and in another way presently to be mentioned to the unwholesome state of the ward.*

4. The foregoing conditions are in operation more or less at all times. The operation of the condition now to be described is limited to the winter months. The Accident Ward is partly warmed by a hot-air shaft passing longitudinally along the centre of the ward, and having openings at intervals. No arrangements have apparently been made for cleansing this shaft from end to end, and it is to be inferred that during the several years it has been in use much dust, mostly surface-dust containing organic matter, will have collected within it, and that some of this dust will be carried by the current of air which passes along the shaft into the ward. But this shaft, in addition, contributes in a special manner to vitiate the air of the ward from the relations of its inlet to the laundry. The air to supply this shaft is, in fact, obtained from an aperture on the surface of the ground, almost directly opposite the door of the laundry, twelve feet distant from this door, and ten feet from a stand adjoining the door, on which is placed the dirty and infected linen removed from the wards, before being taken into the laundry. The shaft, indeed, obtains its air from the one spot in the Infirmary premises where the atmosphere is most fouled and is most liable to be fouled. At the time of one of my examinations of this inlet of the shaft, three baskets filled with foul linen were placed on the stand adjoining the laundry door, and one of these baskets contained the bed linen used for a case of erysipelas. These baskets had been there several hours, and were likely to remain several hours longer. That morning, indeed, I satisfied myself that the air passing into the shaft for the supply of the Accident Ward, in addition to ordinary surface-dust, and the dust from recent ashes sifting, was charged also with steam from the laundry, and with the emanations of foul and infected linen. Probably, also, it contained some sewer air, for if, as I suspect, part of the air of the drain into which the laundry drains is diffused into the surrounding soil, some of this is likely to find its way into the hot-air shaft; for the inlet of the shaft, in its course to the heating furnace, is sunk between the Accident Ward and the drain, within a few inches of the latter.

Such are the different conditions which I believe to have co-operated in producing that unwholesome state of the Accident Ward as indicated by the occurrence of erysipelas in it. It is quite possible that the influence they have exercised upon the ward may have been accumulating from year to year, as certain facts I have stated in a previous part of the report might indicate. In regard to this question, the structural deterioration which buildings are liable to undergo in the course of years is not to be overlooked. As for example, in such cases as the one under consideration, deterioration of walls and floors, however excellently constructed, admitting of increasing lodgments of dirt; or the deterioration of the mechanism and metal fixings of closets, sinks, &c.; or again, and especially, deterioration of drains.† The different

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[* *See* suggestion as to this drain, last paragraph, p. 66.—J. N. R.]

† The drain receiving the sewage of the Rowney and Marlborough Wards passes beneath the corridor leading to the Accident Ward, and close to the door giving entrance from this corridor to the Bagot Ward. In view of deterioration, this drain should be examined from time to time. It would be well, indeed, that another line of direction should, if possible, be found for it.

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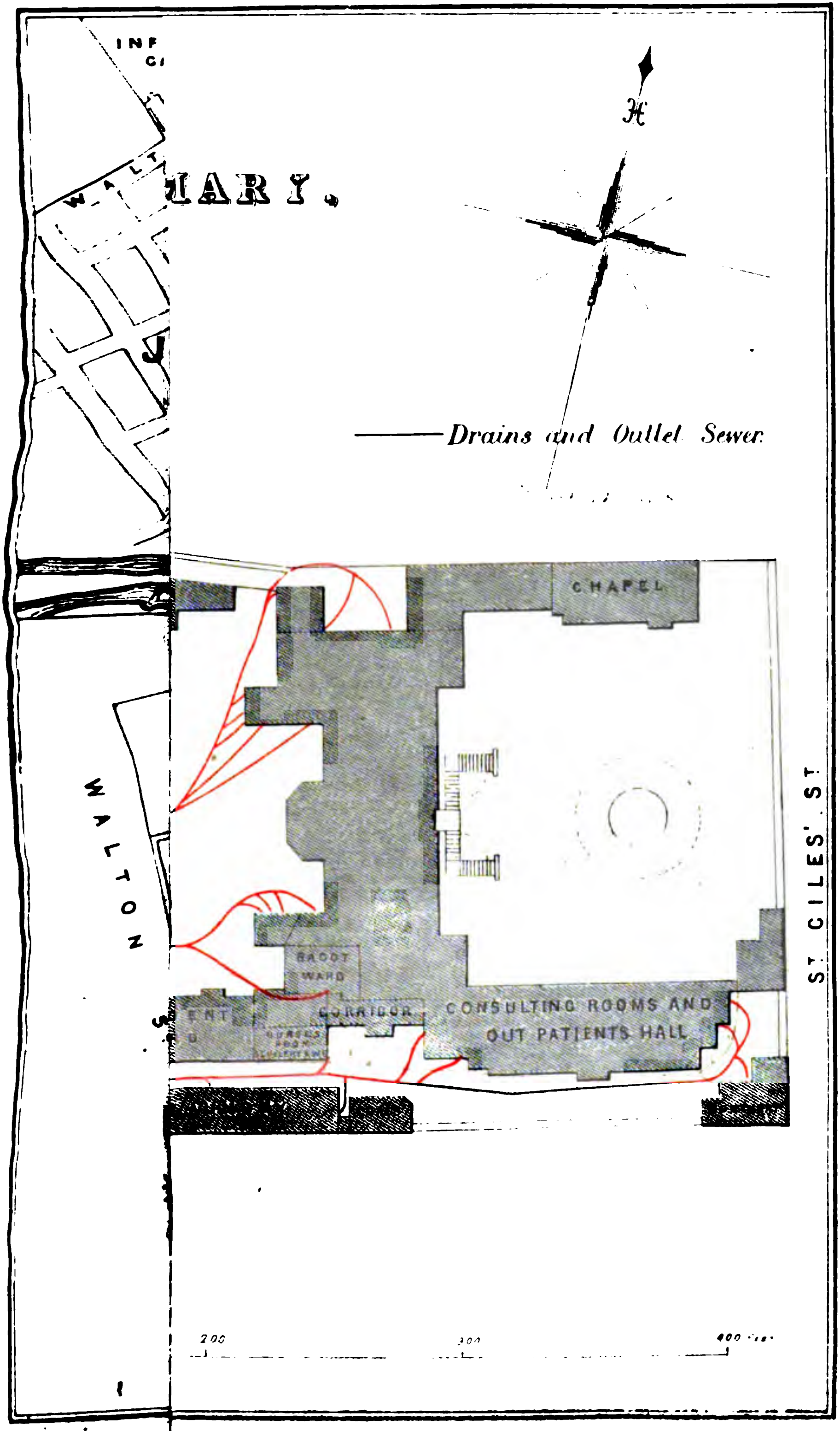
General to the Infirmary.

The last time this operation was performed was at the close of September, or beginning of October 1874, when blocking of the drain was made manifest from sewage forcing its way to the surface above the point of stoppage. Eighteen months before, that is to say, in the spring of 1873, a similar stoppage had taken place, requiring like interference. Below the Clarendon Press the continuation sewer runs without obstruction until the siphon beneath the canal is reached. There much deposit of road detritus, and of filth (chiefly brew-house) takes place, and it is necessary to flush the siphon once a week to keep it clear.

Along the whole course of the Infirmary main drain and its branches, and the old sewer with which the main drain communicates, the sole provision made for ventilation consists of the [so called] ventilating-pipes attached to the soil-pipes of the different waterclosets in the Infirmary and in the New Fever Block, and carried above the roofs of the respective buildings. The continuation of the sewer through Jericho is ventilated by means of the road-gullies which open into it, and which are untrapped.

It would appear, then, that throughout the whole period of that development of erysipelas which forms the subject of inquiry, and preceding it, the solid filth sent by the Infirmary, by the Clarendon Press, and by such other houses as have the same drainage outlet, into the old sewer which has been described, was slowly accumulating there until, nearly four months after erysipelas had begun to spread in the wards, the stoppage was complete. During all that time the Infirmary drainage was passing into a cesspool, in which decomposition of the retained filth was facilitated by the warm condensing water poured into it from the Clarendon Press engines, and the hot water occasionally thrown in when the engine-boilers were flushed out. The gases evolved from the decomposing filth had no outlet from the sewer except by diffusion through its walls, or by escape along the Infirmary drains and outflow upon the roof of the main building and the New Fever Block. It can hardly be doubted that there must have been frequent large, if not continuous, outflow of sewer air and gases from the soil-pipe ventilators during the growing accumulation of filth in the sewer, and at the time of its stoppage. For the warming of the upper portion of the main drain by the hot water poured into it from the laundry would, apart from any tendency of the sewer gases to rise to the highest point of the drain, determine an up-current in it; and under a rapid fall of the barometer, the atmosphere above the hospital would be flooded with sewer air. It is unlikely, moreover, that the traps of the drains from the Accident Ward should, under such conditions, at all times have remained sealed, and that, more or less, sewer air would not occasionally be diffused under its western windows. It is unlikely, also, that some diffusion of sewer air would not take place through the watercloset traps elsewhere within the Infirmary. Indeed, it may be inferred that during the period under consideration, the condition of the atmosphere about and within the Infirmary differed little as to pollution with sewer air, from that which would exist in other parts of the city where the drainage and sewerage are imperfect. Such pollution is one of the most powerful causes determining traumatic erysipelas, and its coincidence with the recent prevalence of that disease in the Infirmary appears to me to explain the concurrence of the prevalence in the wards with the prevalence of erysipelas in the city. In other words, it gives an explanation of the Infirmary not being exempted, as it most probably would have been if its hygienic arrangements had been such as they were believed to be, from the more general conditions which determined the pre-

To illustrate Mr. Netten Radcliffe's Report.



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valence in the city, and which in the Infirmary were manifested by an increased susceptibility of injuries and injured persons to the disease.

It remains for me now to consider the conditions which admitted of infection becoming an active agent in the diffusion of erysipelas within the wards. These were as follows :—

Conditions favouring Diffusion of Erysipelas.

1. The removal of cases of erysipelas from the wards, and their isolation, after it became evident that transmission of the disease was probably taking place from case to case, was not carried out in any systematic manner. A glance at the table will show, that notwithstanding the removal and isolation of many cases,* others were treated in the wards in sufficient number to perpetuate contagion there, and to maintain an infected state of the wards.

2. The long freedom of the Infirmary from highly infectious erysipelas had led to several of the precautions usually adopted by surgical staffs and attendants falling into disuse, such, for example, as the careful cleansing and disinfection of hands and instruments in passing from cases of traumatic erysipelas to other surgical cases.

3. The use of absorbent materials for dresses by nurses when on duty, each nurse being allowed to wear what kind of dress she liked in the ward, if it admitted of being washed.

4. The rotation of night service, by which every nurse takes duty in turn in the Accident Ward, a regulation which may make them carriers of infection to other parts of the hospital in the event of a case or cases of erysipelas, or other traumatic infection being present in the ward.

5. The use of infection-traps, called bed-curtains.

6. The juxtaposition of infected and dirty linen, and their washing in the same laundry.

It will be observed that the opportunities for the transmission of the contagion of erysipelas to the different parts of the hospital were so numerous, that at the first aspect it would appear as if this alone were sufficient to account for the prevalence of the disease after it had once declared itself. A study of all the phenomena of the prevalence leads, however, to the conclusion, as being more probable, that these are most clearly accounted for by the combined and continued action of the causes which first determined the outbreak and of infection.

Before passing to the recommendations I have to make, there is another question to which it is requisite that I should direct particular attention. I refer to persisting infection of wards in which erysipelas has occurred. It is one of the phenomena of this disease, when it shows itself in an infectious form in surgical wards, that the ward may become infected for an indefinite period by it, newly-admitted patients being from time to time attacked long after the removal of the original infecting case or cases. The probability of such persisting infection, undoubtedly dependent upon the facilities which the ward and its furniture afford for retaining, or, in other words, for the adherence of the infection of the disease, must not be lost sight of in the measures taken for obviating further mischief in the future.

Summary Conclusions.

Summary of Conclusions.—If the statements I have made of the results of this inquiry are as clear as I should wish them to be, the measures necessary to prevent a recurrence of serious prevalence of erysipelas in the Infirmary will be sufficiently obvious. The conclusions

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* Removal of a patient from the Accident Ward to the Bagot Ward cannot rightly be considered as isolation.

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at which I have arrived respecting the origin and development of the recent prevalence of erysipelas in the wards are, briefly recapitulated, as follows:—

As to Origin.

This, in the first instance, is to be attributed to an impure state of the atmosphere of the Accident Ward, arising from (*a*) the contiguity of the laundry; (*b*) the screening of ashes and house-refuse beneath the windows; and (*c*) imperfect arrangement of the drain and its connexions adjoining the ward, and of the outlet drain (the main drain) of the Infirmary with which that drain communicates.

As to Subsequent Development.

This was due to a combination of hygienic faults and of defective ward regulations.

1. With regard to the *hygienic faults*, these, as to the Accident Ward, consisted of the conditions already named, with the addition, in the colder months, of the heated air used for warming the ward being liable to pollution, and, in all probability, being ordinarily much polluted. As to other wards, these were exposed, more or less, to fouling of their atmosphere with sewer air from want of ventilation and otherwise defective arrangement of the main drain of the Infirmary, and from the utterly bad state of the sewer with which the main drain communicates.

2. With regard to *defective ward regulations*, the deficiencies referred to as tending to exceptional fouling of the wards, or to the diffusion of erysipelas by contagion, or to both, were (*a*) the absence of a definite system of isolation or separation of the several cases as they occurred; (*b*) the liability to relative or actual overcrowding of wards; (*c*) the want of proper provision for preventing the dissemination of contagion by the fingers of the surgical and medical staff or attendants, by the dress of the nurses, and by the use of the same laundry for infected and uninfected linen and bed-furniture; and (*d*), finally, the likelihood of the different nurses, in the event of traumatic infection existing in the Accident Ward, becoming in succession carriers of the infection from that ward to other parts of the building.

RECOMMENDATIONS.

Recommendations.

The recommendations I have to make for the removal of the various faulty arrangements which have been described, are as follows:

(*A.*) *As to Hygienic Defects other than of Drainage and Ward Regulations.*

1. The laundry should be removed from its present position, as also the drying-ground, to some other part of the Infirmary premises, at a distance from the Accident Ward and other wards.

2. The place for screening ashes should also be removed, and so placed that the dust diffused in the process of screening should not find its way into any of the wards.

3. The hot-air shaft of the Accident Ward (if hot-water pipes and coils be not substituted for it, which would be better), should be so arranged that it can be readily swept from end to end. The inlet of this shaft should, moreover, be transferred to the north side of the building, and there carried up above the eaves, where the air is less likely to be charged with dust and other dirt. The vertical shaft, as the horizontal, should be arranged so as to admit of ready cleansing within.

Recommendations.

(B.) *As to Defects of Drainage.*

4. The drain which runs to the south of the Out-Patients' Hall and Accident Ward should, after careful examination into its present state, and the putting right of any deterioration which may be found, have its upper end freely opened to the air. This may be effected by carrying a ventilating pipe (of at least four inches diameter) from this end up to the roof of the Out-Patients' Hall, the outlet being at some convenient spot on the ridge.

Provision should also be made for the frequent flushing, at regular intervals, of this drain. For this purpose a flushing-tank should be placed at the upper end, or the drain might be extended to the fountain in front of the Infirmary, and flushed from the basin. The former plan, I think, would be best, for, if the drain were extended to the fountain, unless an opening for ventilation were made on the surface of the ground, close to the basin (which from the locality would be undesirable, even if a charcoal diaphragm were used), a blind end, always objectionable, would be formed above the point where I believe ventilation can be most readily effected without detriment to the neighbouring wards.

Further, the several soil-pipes communicating with this drain should be fully ventilated independently; and the sink and other pipes connected with the drain should not communicate directly with it. These latter pipes, as in the case of the lavatory-pipe, and soil-pipe of the Accident Ward, should terminate at the outer wall of the building from which they come. There they should end in a small chamber, covered only by a freely perforated grating (open, in fact, to the air); the inlet of the pipe communicating with the drain, properly trapped, being on the further side of this chamber.

The same arrangement should be made for all sink, lavatory, and bath pipes in the Infirmary not connected with soil-pipes, provision being made for the ventilation, in the manner described, of all drains trapped at the inlet.

The cutting-off of direct communication between the drains within a building and the drains outside, also of the drains with the common sewers, with free ventilation of soil-pipes and drains, constitute the greatest safeguards against fouling of the atmosphere in and about buildings with sewer air. This arrangement of drains does not appear to have been adopted at the Infirmary, except in the case of the drains of the waterclosets, slop-sink, and lavatories of the Accident Ward. The only precaution which appears to have been taken to prevent diffusion of sewer air into other parts of the Infirmary has been the [so-called] ventilation of the soil-pipes, previously described (p. 54), and this, as I have had to mention, not uniformly. I am not prepared to suggest a re-arrangement of the drains of the kind referred to, except in so far as it may be effected without reconstruction being requisite, or where there is direct evidence of its necessity. Such necessity exists in the drain running south of the Accident Ward, which has already been considered, and in the main drain of the building.

It is indispensable that the main drain should be cut off from direct communication with the sewer into which it opens. A break should be interposed in some part of its course, preferably at the lower part of the garden, so arranged that it would interpose an obstacle to the upward passage of sewer air from below, and if such passage should be effected, would direct the sewer air harmlessly

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into the open air. Professor Reynolds, of Owen's College, Manchester, has designed an arrangement to meet these objects, which appears to me excellently adapted for the purpose. It consists of a man-hole, about two feet square, sunk to the drain. Above, the man-hole is covered by a perforated grating; at the bottom, it is traversed by an open depressed channel which takes the place of the closed drain, and into which the upper and lower openings of the drain, at the point of interruption, dip, so that the drainage in all states of flow covers both openings. The double water-trap thus formed protects the upper portion of the drain, if sewer air should be forced through the trap from below, and any such upward flow of sewer air, or diffusion through the water of the trap, passes upwards along the man-hole to the outer air. Professor Reynolds has described this arrangement with illustrations in a readily accessible work, and to this I refer for further details.*

It must be obvious that if the main drain of the Infirmary had been broken in its course to the outlet sewer, as is here suggested, no such evil influence would have been exercised upon the wholesomeness of the Infirmary by the state of the outlet sewer, as I believe to have taken place. Certainly the condition of the outlet sewer ought no longer to be tolerated, and representations should be made to the City Authority on this subject. Meanwhile, by adopting the precaution suggested, the Infirmary drains may be wholly cut off from any harmful effects from the city sewers, and it ought not then to be difficult to keep these drains in proper order.

To this end, the cutting off in question having been effected, it is possible that the free ventilation of the soil pipes, with the introduction of three or four surface ventilators along the course of the main drain, may suffice for the efficient ventilation of the whole series of drains. The surface ventilators of the main drain may have charcoal diaphragms if it be thought fit, but this should hardly be neccessary if the drain is in good order. Any marked odour from a ventilator should be regarded as an indication that the drain had got out of order, and wanted attending to by flushing or otherwise, rather than as an indication for deodorization of sewer air. The ventilating pipes attached to the soil pipes in the main building should be enlarged to four inches diameter, and they should be carried up to the ridge of the highest adjoining roof. The existing ventilating pipes have their outlets in dangerous proximity to the ventilating openings of ward offices.

(*C.*) *As to Defects of Ward Regulations.*

5. The systematic isolation of cases of erysipelas appears to me to be essential to the successful limitation of the disease. Treated in a ward with other kinds of disease, whether surgical or medical, it is usually found prudent, even when the malady shows least indication of infectiveness, to give a patient suffering from erysipelas greater bed space, by disusing the adjacent beds, or one of

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* "Sewer Gas." By Osborne Reynolds, M.A., Professor of Engineering at Owen's College, Manchester. 1872. Spon, Charing Cross. [Another arrangement to meet the same objects has been designed by Mr. Rogers Field, C.E. Mr. Field, retaining the ordinary siphon trap, opens the drain freely to the outer atmosphere on the house (or other building) side of the trap. By this plan the force of the current of sewage is not diminished in passing through the trap, as in Professor Reynolds's trap, and tendency to accumulation of solid matters in the trap is more surely obviated.—J. N. R.]

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them, in addition to the various special measures for preventing the diffusion of infection from the case, which are necessary parts of successful ward management. It is found prudent, in fact, to do at least imperfectly what can be done completely by isolation. The occurrence even of a single case of infection from the neglect of an available precaution is to be deprecated. The history of the little groups of cases which are apt to occur in surgical wards, during periods when traumatic infections show little disposition to prevail, is very commonly a history of transmitted infection.

It must be apparent that the isolation of cases of erysipelas and allied infections, while of itself one of the most important means of preventing diffusion of the disease, favours enormously the use of other measures, and involves the least disturbance of the ordinary ward regulations. For example, to bring the different nurses of the Infirmary successively into relations with the Accident Ward or other ward, at times when erysipelas or other traumatic infections are being treated in it, and to maintain the free communication by the different attendants and officials between the various wards, seems to me indefensible. Obviously, isolation of the cases of traumatic infection as they occur would involve less inconvenient disturbance of the ordinary arrangements of the Infirmary, and besides being more effectual as a means of preventing transmitted mischief, it would obviate almost altogether a diminution of the number of available beds.

Further, in the interest of the patient, it is desirable that each case of traumatic infection should have larger bed-space given to it than even the Accident Ward with its present number of beds affords. In no class of diseases is abundant ventilation more necessary than in the traumatic infections, and no class so readily responds to the beneficial influence of free change of the air about the patient. It is matter of experience that in ordinary infectious diseases such freedom of ventilation as is desirable cannot certainly be obtained in permanent buildings if each occupied bed have less than 2,000 cubic feet of air-space, and 144 square feet of floor-space, with correspondingly large facilities for ingress and egress of air. What is true of ordinary current infections is true also, according to my experience, of traumatic infections; and I am of opinion that until the measures which are held advisable for the limitation of ordinary current infections are stringently applied to traumatic infections, there can be no reasonable hope of their being brought under such control as should be aimed at in hospitals.

6. In all the wards, with the exception of the Accident Ward, the liability to relative overcrowding is imminent, and even in the Accident Ward, from its particular purpose, as indicated by the name, the chance of such overcrowding should not be overlooked. The floor-space and cubic space for each patient, with corresponding free ventilation, which form the ward conditions most favourable to the beneficial progress of infectious cases, constitute also the ward conditions most favourable to the prevention of the morbid changes known as traumatic infections, and of which erysipelas is an example. Certain kinds of injuries are apt to undergo these changes, such as lacerated wounds, particularly of the scalp and extremities, and compound fractures. All such wounds, and also injuries involving much suppuration, or mortification or sloughing of tissue, should have given to them, irrespective of any indication or existence of a traumatic infection in a ward, much more floor-space and cubic-space than the best-constructed surgical hospital

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allows as an average for its beds, when the full complement is filled. In other words, the usually stated bed accommodation of wards should be regarded as the accommodation for the ordinary run of cases. Within this limit no hard-and-fast rule of occupation should be insisted on, but the number of used beds should depend wholly on the nature of the cases admitted, with reference to their liability to foster traumatic infections.

It is not necessary for me to do more than state these general principles of ward management as to overcrowding. Their application in detail is only possible with a knowledge of the intimate working of the Infirmary, which is not to be gathered from a brief inquiry like this I have been engaged in. I would suggest, however, as to the attics (if they are to be retained for use as wards), that besides a necessary redistribution of beds to diminish overcrowding, it might be desirable to introduce other dormer-windows into the roofs.

7. The provision of abundant means for the removal and destruction by fire of all absorbent materials used in the dressing of wounds, and for the cleansing and disinfection of the hands of the surgical staff and attendants, I need only refer to briefly. For the practice as to dressings is in force in the wards, and materials (such as sponges) at one time used in common for several patients, have long been disused. To disinfection of the hands, and even of instruments (as, for example, by chlorinated solutions), after dressing cases of traumatic infection, I attribute considerable importance; and free provision for such disinfection should be made in the wards, the ward attendants being required to make uniform use of it. It is desirable that definite provision should also be made for the destruction of surgical dressings, and that they should not be left, especially during the summer months, to any haphazard use of fires or furnaces. A gas furnace, constructed for the purpose, attached [or accessible] to each surgical ward, would perhaps best meet this provision.

8. The nurses should be required to wear, when on duty in the wards, dresses of material neither apt to absorb moist nor to collect solid filth, and which should also be washable. Several kinds of material exist having these characters, and fitted for ward use.

9. The rotation of night-service by which nurses in the different wards take duty in turn in the Accident Ward, if not changed for some different system, should be interrupted, as long as cases of erysipelas or other traumatic affections exist in that ward, or there is reason to believe that traumatic infection persists in it.

10. Bed-curtains, if at all continued in the wards, should at least be done away with in all cases of erysipelas or other traumatic infection, and in cases liable from their nature to be attacked with such infection.

11. The matting placed upon the bed-frame, beneath the bed, should in all cases when it is necessary to stove the bed, be stoved also.

As to Washing of Linen, &c.

12. The laundry already built for infected linen should at once be brought into use, and such linen should under no circumstances be placed in proximity to uninfected linen.

As to Persisting Infection of Wards.

13. In the event of infection persisting in any of the wards, as indicated by cases of erysipelas occurring there at intervals among

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the patients admitted, it will be necessary, after thoroughly cleansing the infected wards, to disuse them for three or four months, repeating the cleansing from time to time, and exposing the ward during disuse to continuous free ventilation. If such a measure should be requisite, it would be well also, while the wards are out of use, to treat all surgical cases admitted into the Infirmary in hospital marquees or huts erected in the garden, according to convenience or state of season.

Independently of the foregoing consideration, it may deserve attention whether, in the present state of the hospital, all cases requiring operation should not be dealt with in tents or huts.

As to Registration of Traumatic and other Infections.

14. Until a definite registration is established of the various diseases, infectious and others, originating in the Infirmary and its different wards, it will be impossible to gauge with precision the sanitary condition of the building, and to ascertain whether the constant and necessary tendency to fouling of the wards is effectually controlled.

It is requisite that all diseases originating in the Infirmary (whether among patients or attendants) should be carefully registered, distinguishing the infections from the non-infections. I would suggest that the weekly report presented to the Committee should show these cases, as also cases of infectious disease admitted into the Infirmary, and the nature of the cases in each surgical ward.

As to the Sanitary Supervision of the Infirmary.

15. I disbelieve in the effective sanitary supervision of a hospital unless some officer or officers on the spot be made definitely responsible for the duty. I venture to suggest that the house-surgeon and house-physician should be made responsible for the sanitary regulation of the wards under their respective observation, and for such of the general sanitary arrangements of the Infirmary as are connected therewith. To this end, as well as for the assistance of the Committee, detailed plans of the drainage and water arrangements should be prepared. The plans of drains should show the position, and indicate the nature, of every trap and of every ventilating aperture. These plans ought to be framed, and hung up either in the Board Room or the Secretary's Room, or elsewhere (but preferably the first-named room) where they can be readily consulted. The conspicuous exposure of the plans is necessary to familiarize the various responsible persons with the details to which they refer.

J. Netten Radcliffe.

1st February 1875.

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26th May 1876.

POSTSCRIPT.

26th May 1876.—A few days after the inquiry had terminated, and before the Infirmary was free from the infection of erysipelas, a large number of persons injured, some very seriously, in an accident which had occurred (24th December 1874) on the Great Western Railway, at Shipton, were received into the wards within a period of from two to three hours.

The rapid succession in which the patients arrived at the Infirmary, and the exigency of the occasion, rendered it necessary at first to distribute them in the wards wherever bed-space could be found, without regard to the previous occurrence of erysipelas there. During the whole time these patients were under treatment, one only was attacked with erysipelas; and no other form of traumatic infection occurred among them. It is an interesting question whether this remarkable exemption, or any part of it, was owing to measures which had been adopted with a view of freeing the Infirmary from the infection of erysipelas before the admission of these cases, or to measures which were put in operation after their reception.

It was on the 5th December 1874 that I finished my inquiry and submitted provisionally the conclusions I had arrived at, together with the recommendations I had to make, to the Committee of Management. Since the month of October all cases of erysipelas occurring in the wards had been at once removed and isolated in a separate block of buildings, the so-called New Fever Block, and at the time of my inquiry the disease had manifestly diminished in frequency of recurrence. While the different measures I had suggested for the regulation of the wards were under discussion, and the removal of certain sanitary defects about the building which I had pointed out were in progress, the Shipton accident occurred, and provision had to be made for the immediate reception of over 50 cases of injury. At this time the number of patients in the Accident Ward and the North Attic Ward, the two wards which had suffered most from erysipelas, had been much lessened as a precautionary measure, but it was now necessary to refill these wards and to make use of every available bed in the building.

As soon as the immediate necessities of the several cases had been met, special measures were taken to diminish the risk of erysipelas to which the patients were exposed. First of all, a general removal was directed of all the medical and surgical cases in the Infirmary not too ill to be sent home; and fresh admissions were restricted to cases of severe injury or acute disease. By the clearance thus effected, and by fitting up the Board Room as a ward with six beds, it became practicable to remove, on the 25th December, the day after the accident, all cases from the Accident Ward, where the danger of erysipelas was most dreaded, with the exception of one case, too ill to be removed; and in the course of the four following days the North Attic Ward, where the liability to recurrence of erysipelas had been next in order to that of the Accident Ward, was cleared of all Shipton cases. It became practicable also to distribute the Shipton cases in the other wards of the Infirmary without any overcrowding.

The accompanying Table (B) gives:—

1. The final "warding" of the Shipton cases after their redistribution.
2. The number, kind, and length of stay of the said cases in each ward.

TABLE B.—Showing the FINAL "WARDING," &c., of the PATIENTS admitted into the RADCLIFFE INFIRMARY from the SHIPTON RAILWAY ACCIDENT.

Name of Ward.	Number of beds in Ward.	Number and Nature of the Shipton Cases admitted into it.	Length of Stay.	Erysipelas cases occurring in the Ward during the past Epidemic.	Date of *last* case of Erysipelas in the ward previous to the Shipton admissions.	Cases of Erysipelas occurring in Ward for the Three Months after the Shipton Admissions.
Large Accident Ward, Male.	20	1 case: Fractured humerus and femur, with various contusions.	64 days - - -	8	Decem. 9, 1874 -	1 case on December 27, *not* a Shipton case.
Small Accident Ward, alias "Bagot."	5	4 cases: 2 severe lacerations. 1 contusion. 1 simple fracture.	From 13 to 65 days -	1	July 7 " -	None.
Marlborough. Male, Surgical.	17	11 cases: 4 lacerations. 5 contusions. 1 compound fracture and lacerated scalp 1 simple fracture.	From 7 to 31 days -	2	August 31 " -	2 cases. 1 a Shipton* case on January 2. 1 a *non*-Shipton case, February 3.
Board Room. Males -	6	6 cases: 2 bad compound fractures, one a primary amputation. 1 laceration. 3 contusions.	From 7 to 55 days -	—	—	The day nurse (Mills) in sole charge of this Ward *had previously been nursing in large Accident Ward.* At end of 13 *days* duty in Board Room she sickened with erysipelas of face, and had a very severe attack. Not one of her patients took the disease.
Litchfield. Female, Surgical.	17	9 cases: 4 lacerations, 2 contusions. 2 simple fractures. 1 compound do. with various lacerations.	From 7 to 62 days -	2	August 30 " -	None
Rowney. Male, Medical	17	1 case: Lacerated scalp and contusions.	13 days - - -	4	Nov. 28 " -	None.
Children's Ward. Mixed, Medical and Surgical.	8	4 cases: One only an open wound.	From 2 to 13 days -	—	—	None.
Frewen. Female, Medical.	17	1 case: Fractured femur and compound fracture of leg, arms badly bruised.	97 days - - -	—	—	1 case on February 11th, the day after patient's admission. Here the disease was most probably incubating on admission and could not be set down to the Frewen Ward.
South Attic. Female, Surgical.	13	4 cases: 2 contusions, one with fracture. 2 lacerations severe.	From 5 to 62 days -	1	Sept. 20 " -	None
East Attic. Mixed, Medical and Surgical.	7	3 cases: Two open wounds. One contusion.	From 11 to 24 days -	—	—	None.
West Attic. Mixed -	4	1 case: Fractured arm and base of skull.	38 days - - -	1	Sept. 16 " -	None.
North Attic. Surgical -	13	4 or 5 cases: Two of them severe lacerations.	None beyond 5 days -	5	Decem. 9 " -	None.

* This case—the only case of erysipelas among the Shipton patients—was removed to this Ward from the large Accident Ward, where a case of erysipelas occurred on *December 27th*.

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3. The risks of erysipelas incurred by them (so far as such risk can be measured by the prevalence of the disease in the several wards before and during their occupation of them).

Three of the Shipton cases, it may be here mentioned, died from the severity of their injuries within two or three days after admission, and twelve, or thereabouts, were able to leave the Infirmary within a week.

In addition to the clearance of the Accident and Marlborough Wards and the scattering of the cases as much as practicable in the other wards, the Board Room, as already mentioned, being also converted into a ward to meet the exigency of the occasion, the following precautionary measures were adopted.

As cases of erysipelas were still occurring sporadically in and about the city, the ordinary visiting of patients in the Infirmary from outside was suspended, the relatives and friends of the Shipton cases, and of such other cases as might be seriously ill, alone being admitted into the wards.

Further, the system of nursing in force at the time of my inquiry (*see* Report, p. 55) was entirely changed.* The night nursing was no longer done by the day nurses in rotation, but by six nurses hired from without, and by them exclusively. Also, to prevent unnecessary intercommunication among the nurses, the practice of their dining all together in the kitchen was stopped, and each nurse had her dinner sent up to her room. No one of the ordinary day or night nurses had any intercourse whatever with the New Fever Block, then used solely for isolating cases of erysipelas.

Again the linen and bed clothing from the erysipelas wards (New Fever Block) were not, as heretofore, dealt with in the general laundry (Report, p. 55), but were from first to last kept clear of that building, and washed in the special laundry, which had lately been built in the garden, at some distance from the Infirmary, for dealing with all infected linen.

Moreover, the use of absorbent materials for the dress of the nurses when on duty was forbidden, and a uniform dress of washable material substituted. For the moment also, the use of bed curtains was done away with.

Hardly less important changes than were effected in the general management of the patients were carried out in the dressing of the wounds. All the sponges in the Infirmary in use up to the time of the Shipton accident were burnt. New sponges were not altogether discarded, but, as a rule, the wounds were cleansed with carbolised tow. Entirely new bandages and draw-sheets were used in every case. The practice of washing the hands in water, to which a liberal quantity of Condy's disinfecting fluid had been added, was strictly enjoined upon the nurses after each dressing, and was followed by the surgeon in charge of the Shipton cases, Mr. Symonds, and by the House Surgeon, Mr. Morgan. The great majority of the wounds were dressed with simple wet lint; in a few cases only the lint was soaked in carbolised oil instead of plain water. The fouled dressings were no longer burnt in the wards, but were collected in a bucket every evening, by the house porter, who carried them to the furnace of the disinfecting chamber, attached to the laundry for infected linen, in the garden, and burnt them there.

The wounds of the patients who recovered, I may add, did remarkably well under the kind of dressing adopted, primary union, I am informed, taking place in every case where it could be reasonably expected, and in not a few cases where it had not been hoped for.

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* This change was made temporarily only, in consequence of the usual nursing staff being unable, in addition to the ordinary duties of the wards, to meet the needs of the numerous cases of injury admitted from the Shipton accident. The old system of night nursing is still practised.

While the changes above described had been made in the management of the wounds and hygienic care of the patients, the defects which I had described in the hygienic state of the Infirmary and its surroundings were not neglected.

The practice of screening so-called ashes under the windows of the Accident Ward was discontinued. Steps were also taken for the erection of a new general laundry, to form part of a block of building including the infected linen laundry, but with wholly separate washing and drying arrangements. The plans for this laundry had been prepared some time before my inquiry; but the building is not yet completed, and the old general laundry and drying ground are still in use.

The hot-air shaft of the Accident Ward was cleansed, and its inlet, previously at the level of the ground, carried by a brick shaft to the eaves of the building, about the middle of January 1875. The cleansing of the shaft dislodged an immense quantity of "fluff," which had accumulated there.

In February 1875, two 4-inch ventilating pipes were connected with the drain, previously unventilated, which runs south of the Out Patients' Hall and the Accident Ward. One of these pipes was attached to the upper end of the drain opposite the mortuary, the other was attached at the point where the drain, along with other drains from the main body of the Infirmary and the New Fever Block, joins the main drain to the west of the Accident Ward. Arrangements were also made for flushing the drain in question from the mortuary.

The ventilating shaft last mentioned is placed, in fact, at the head of the main drain, its outer opening being carried to the ridge of the Accident Ward. Another 4-inch ventilating shaft has also been attached to the main drain at a point opposite the infected linen laundry, and has been carried up the wall of that building to the eaves. No provision has, however, been made to prevent reflux of sewer air into the main drain and Infirmary premises from the common sewer into which the main drain opens (Report, p. 54).

I may also add here that arrangements have been made for the sanitary supervision of the Infirmary, and for the registration of traumatic and other infections in the wards. The House-Physician and House-Surgeon take the entire sanitary care of the Infirmary in alternate months, the plan, I am informed, working very well. I append a copy of a Sanitary Return (Table D), which is prepared by the Resident Medical Officer in sanitary charge of the building for the time being, and presented to the Committee of Management at its weekly meetings.

A detached building to contain 16 beds for infectious disease is also being erected at the further extremity of the garden. When this building is completed the wards of the New Fever Block (so-called) will be used for the reception of ordinary medical cases.

In Table C, I give particulars relating to the cases of erysipelas which have been under care in the Radcliffe Infirmary from the completion of my Report to the date of this Postscript. The case last recorded in the Table appended to the Report originated in the Accident Ward, on the 9th December 1874. On the 27th December, the third day after the reception into the hospital of the patients from the Shipton accident, another case of erysipelas originated in the Accident Ward, (*Henry Edgington*), the patient having been admitted on the 18th December from Woodstock, with lacerated fingers. The next case following of erysipelas, a slight one, occurred on the 2nd January 1875, when a man who had been injured in the Shipton accident (*Wilmer Read*), and who had first been placed

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in the Accident Ward, and was afterwards removed to the Marlborough Ward, was attacked. This was the only case of erysipelas which happened among the Shipton cases. Four other cases of erysipelas occurred in the Infirmary during the period which included the stay of those cases there, namely, (1) the nurse (*Mills*) in day-charge of the patients, all from the Shipton accident, in the Board Room, who was attacked on the 7th January; (2) a patient (*Louisa Griffin*), who was admitted from Oxford, into Frewen Ward on the 9th February, for an inflamed bursa over the patella and acute nephritis, and who was attacked with erysipelas on the 11th February, the disease probably having been contracted before admission; (3) a patient (*William Fortnum*), who was admitted from Banbury into Marlborough Ward on the 3rd July, for chronic disease of leg bones, was operated upon for removal of dead bone on the 10th February, and was attacked with erysipelas on the 11th; and (4) a patient, a child two years and a half old (*Pleasant Martin*), who was admitted from Standlake, into the Old Fever Block, on the 3rd February, for gangrene of the toes of both feet (from cold and starvation combined) and who was attacked with erysipelas on the 8th March.

On the 3rd March a case of erysipelas (*Albert Hall*), was admitted into the New Fever Block, from Oxford.

From the 8th of March to the 28th May, a period of nearly three months, no case of erysipelas was admitted into the Infirmary from without, and no patient contracted the disease within the wards.

On the 28th May a patient (*Joseph Franklin*), who had been admitted into the Marlborough Ward, from Bicester, on the 7th May, for a diseased elbow, was attacked with erysipelas. From that date to the 26th October five other cases originated in the Infirmary, and three cases of erysipelas were admitted from without, in the course of September.

From the 26th October 1875 to the date of this postscript (26th May 1876) no case of erysipelas has been admitted into the Infirmary, and only one case has originated in it, the patient (*George Dix*), admitted into the North Attic Ward, on the 29th March, for epithelioma of the tongue, which was removed by galvanic cautery, April 6th, having been attacked with erysipelas in the leg (which was eczematous) on the 22nd April.

If now the facts of prevalence of erysipelas in the Infirmary since the period of my inquiry are reviewed, and particularly the exemption of the patients injured in the Shipton accident from the disease, it is to be inferred either that the infectiveness of the disease had remarkably diminished at the time of, and subsequently to, the inquiry, or that the measures taken with a view of limiting the infection had been most successful. On reviewing all the facts, I am disposed to regard the latter alternative as having the greater probability. The entire escape of the patients in the Accident Ward from erysipelas after it had been brought again into ordinary use in the spring of 1875 is particularly noteworthy. It has been suggested to me that the ventilation and regular flushing of the drain which runs immediately outside the ward and with which its offices are in communication, may have a special connexion with this exemption. Without attempting to determine the particular effects of the several measures adopted for purifying the ward, the suggestion is one which deserves consideration, and there can hardly be a doubt that a drain which at times may carry the liquid refuse of a post-mortem room ought not to pass close to a surgical ward, still less to be in communication with the ward through its offices, unless the most scrupulous care has been exercised in its structure and in the arrangements for ventilation and flushing, even if then.

J. N. R.

TABL December 9th 1874, and the 26th May 1876.

No.	Date Admis	Iedical tendant.	Where Isolated.	Result.	Remarks.
1	1874. Dec. 18	Iussey - -	New Fever Block	Recovered.	
2	Dec. 24 1874.	ymonds -	Do.	Do.	
3	1875. Day Nu and W (No. 1.	- -	Do.	Do.	
4	*Feb. 9 '7*	*ray* -	*Do.*	*Do.*	Most likely she brought the erysipelas in with her, for she was very ill on admission.
5	Feb. 3 '7	ymonds -	Do.	Do.	
6	„ 24 '7	*Do*	- - -	*Do.*	Commenced in a sore place in heel and extended to thigh.
7	Feb. 3 '7	Do.	Do.	Do.	
8	*Mar. 3 '7*	*uckwell* -	- - -	*Do.*	
9	May 7 '75	riscoe -	Do.	Do.	
10	June 23 '7	ussey -	Do.	Do.	
11	July 7 '73	riscoe -	Do.	Do.	
12	Aug. 11 '75	ymonds -	Do.	Do.	
13	*Sept. 5 '75*	*Do.*	*Old Fever Block*	*Do.*	
14	„ 26 '76	*Do.*	- - -	*Do.*	Following wound of arm.
15	„ 30 '75	*riscoe* -	- - -	*Do.*	Polypus of nose, with sores there from which erysipelas.
16	Oct. 3 '75	riscoe -	Do.	Died.	
17	„ 13 '75	ymonds -	Old Fever Block	Recovered.	
18	1876 Mar -	Do.	Do.	Do.	Commenced in an eczematous leg.

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TABLE D.—RADCLIFFE INFIRMARY "SANITARY BOOK."

Return for week ending 187 .

Cases of.	Patient's name.	Ward.	When admitted.	Primary disease, or injury.	Nature and date of disease contracted in Infirmary.	When and where moved.	Physician or Surgeon.	Remarks.
A. INFECTIOUS OR SEPTIC DISEASES.								
Febrile Exanthems -								
Erysipelas - -								
Diphtheria - -								
Hospital Throat -								
Phagedæna -								
Pyæmia - -								
B. OFFENSIVE CASES.								

C. VENTILATION.

D. DRAINAGE.

(Signed) ________________ House Physician.

________________ House Surgeon.

B.

MINUTE of CONFERENCES between MR. NETTEN RADCLIFFE and the MEDICAL and SURGICAL STAFF of the NORFOLK AND NORWICH HOSPITAL and OTHERS, concerning the SANITARY CONDITION and ADMINISTRATION of the HOSPITAL, and of an INSPECTION of the BUILDING, the 3rd and 4th August, 1875.

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IN accordance with instructions I visited Norwich on the 3rd August, and in the course of that and the following day I had conferences with the members of the medical and surgical staff of the Hospital then in the city. The engineer who had designed and superintended the construction of the hospital drains, and the architect who had been instructed by the Board of Management to prepare plans of certain suggested alterations were present at the first conference, and I had other interviews with them, as also an interview with a gentleman from the City Surveyor's office. I made, moreover, as detailed an inspection of the hospital and its precincts as the time at my disposal would allow.

Circumstances which led to the conferences.

Prevalence of pyæmia and erysipelas in the hospital.

The circumstances under which the assistance of the Medical Department of the Local Government Board had been requested may be stated briefly as follows:—During the 10 years, 1865–1874, there had been an increasing tendency to fatal pyæmia among surgical cases admitted into the wards; and during the year 1874 and the first three months of the present year (1875) a tendency to fatal erysipelas in the same class of cases had been added. Previous to 1865 the wards had for 10 years (beyond which period the examination of the records has not been carried in the

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Hospital extension.

1. *The Extension of the Hospital.*—The demands upon the hospital appear clearly to have outgrown the present accommodation. To this is traced the source of the recent difficulties. If these difficulties are to be surely avoided in the future it must be, among other things, either by a permanent dimunition of beds in the existing building, or by constructing additional wards. The former alternative, except to meet the present emergency, hardly admits of discussion in view of the increasing needs of the city; the latter has already been under consideration of the Board of Management, and the opinion of Captain Douglas Galton, C.B., has been obtained on the mode in which necessary additions and alterations may be most usefully effected. In a special report on the subject Captain Galton has considered certain requirements of extension submitted to him by the medical and surgical staff, and set forth the principles upon which extensions and alterations should be made, with suggestive details. On some of the secondary questions involved in Captain Galton's report, the information obtained in the course of my recent conferences with the medical and surgical staff, relating to the working of the hospital and the recent prevalence of pyæmia in the wards (information which was not submitted to Captain Galton), has induced me to think that several modifications of his details may be desirable. Or rather, perhaps, that it may be useful in dealing with the proposed alterations and extension of the hospital to consider these with reference also to certain suggestions arising out of a study of the strictly medical and surgical aspect of the questions. The suggestions here referred to will appear in subsequent sections of this minute.

Isolation.

2. *The Isolation of certain Classes of Surgical Cases.*—If the hospital had possessed, as all general hospitals should possess, proper means for isolating cases of traumatic infections as they arose, the prevalence and persistence of pyæmia and erysipelas among the surgical cases in the wards would probably have been almost wholly avoided, even with the existing surgical demands upon them. The registers do not admit of a detailed account of the succession of the different cases of pyæmia and erysipelas, but the tendency to *grouping* of the cases which has been observed would seem to leave little doubt that each case of traumatic infection developed in the wards was the source of a group of other cases by direct or indirect transmission of the infection. This is a common history of prevalence of traumatic infections, and the cardinal principle of preventing such diffusion is the immediate isolation of cases as they show themselves. For this purpose, removal to separate rooms opening off the same ward or corridor communicating with the ward is in no proper sense of the term isolation. The isolation should be of the same kind, and regulated by the same principles as the isolation of current contagious diseases, such as scarlet fever or small-pox. For this purpose, a detached building is at all times necessary, with accommodation also for the nurses in attendance upon the infectious cases. It is not necessary that such a building should be moved to a distance from the main body of the hospital. It is simply needful that it should be fully disconnected, communicating with the main body of the building, if thought desirable, by an open corridor; and that when in use its nursing arrangements should be wholly distinct during that use from the remainder of the building. Food supplied from the common kitchen need not, and ought not, to involve intercommunication between the isolation rooms and the general wards.

My impression is that the best provision for isolation of traumatic infections in the Norfolk and Norwich Hospital would be a single storied pavilion, containing two couples of rooms, one couple for males,

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and one couple for females, with accommodation for nurses. Each ward-room, designed for two beds, should have a minimum floor area of 288 square feet, and a minimum cubic capacity of 4,000 cubic feet. Little difficulty, I imagine, would be found in placing a pavilion of the kind here suggested, either as supplementary to Captain Galton's design, or as substitute for a part of it. If the mansion on the newly acquired ground and now used for separating cases of serious injury and such as need capital operations be retained, it may be a question whether it should not be kept for an isolation block, although another and more appropriate use as a nurses' home might be found for it, could this be satisfactorily reconciled with the internal regulation of the hospital.

Ward infection.

3. *The Question of Ward Infection.*—(*a.*) After the means for isolating infectious cases are secured, the question of protecting the ward from the development of traumatic infections has to be considered in another aspect; and herein questions (1) of bed-space, and (2) of ward regulation, have to be thought of. In this hospital, the surgical cases are intermixed with the medical, and the bed-space in the several wards, is, as a rule, according to received principles of hospital construction, fairly ample. But having regard even to the mere question of bed-space, cases of grave injury admitted into a ward should, it appears to me, be given extra bed-space by the disuse of a neighbouring bed (the bedding being removed), and by limiting the number of these cases in one ward as much as possible.

(*b.*) By the immediate removal of cases of traumatic infection from the wards, the most dangerous but not the sole source of infectious mischief to other surgical cases is done away with. There is a certain liability to septic changes in wounds and the discharges from them, arising, it may be, from unhealthy states of patients, which makes it as undesirable that other patients should be inoculated by these discharges as by the discharges from the well-marked traumatic infections. Although this is perfectly well understood and ordinarily acted upon in the hospital, I would suggest that some general rule should be laid down, applicable alike to dressers and nurses, relating to the washing and disinfection of hands in dealing with all surgical cases, and to the mode of destruction of dressings, and of disinfection of fouled bedding and bed linen. In this regard the questions of dealing with dead bodies, whether in the wards or the dead-house, and of the mode of conducting post-mortem examinations, should have consideration.

(*c.*) The state of the wards and ward furniture which chiefly arrested attention in relation to infection was the fissured and porous condition of some of the floors, the retention of bed-curtains in certain wards especially devoted to surgical purposes, the impediment to free movement of air along the floor beneath the beds by drawers attached to the beds or baskets for the patients' clothes, and the provision of bunks for the nurses within the wards.

Some wards have been newly floored, and others with defective floors can only be properly remedied by this process. The retention of curtains for certain beds commonly occupied by surgical cases appears to be the maintenance of a custom as old as the hospital, unadvisedly kept up out of respect for traditional use. The bed-hamper of drawers and the floor-hamper of baskets, if convenient to the patients and nurses, are prejudicial to the ventilation of wards not otherwise too freely provided in this respect, and serve for retention in the wards of many things which might perhaps be placed elsewhere. The nurses' "bunks" in wards (as I term them, for want of a better phrase) are spaces equal to a bed-space, cut off from some of the wards by a partition several feet in height, open to the ward above, and entered by a door, as a side-lid. These spaces constitute the nurses' bed and sitting-rooms. This arrangement is injurious to the ventilation and purity of the wards, and it is improper on sanitary and other grounds for the nurses. These bunks should certainly be got rid of without delay and other accommodation for the nurses provided.

General sanitary arrangements (a.) Drainage.

4. *The General Sanitary Arrangements of the Hospital.*—(*a.*) The drainage of the hospital has been arranged and constructed with peculiar care. A double set of traps is interposed on each line of drainage between the hospital and the common sewer, irrespective of the traps of the water-closets. The hospital lies near the crest of a hill, and it is drained by several main-drains into one of the city sewers. This sewer is ventilated it would appear at one point only, at some distance below the hospital, and at the crest of the hill above the hospital it terminates in a blank end. On each of the hospital main-drains before it leaves the hospital a siphon trap is placed with examination-pipe closed with a well-fitting iron plate. A like kind of trap is placed at the extremity of each soil-pipe and sink-pipe. The rain-pipes open above the grating of a dip-trap. Notwithstanding this careful arrangement, I am satisfied that the atmosphere within and without the hospital is not so free from the danger of pollution with sewer air as might be supposed. I think, moreover, that the temporary retention of night-soil and sodden paper in the numerous soil-pipe traps close to the hospital is objectionable. I would suggest that (*a*) the plates closing the examination-pipes of the traps of each main-drain should be replaced by a perforated plate, so that any regurgitation of gas from the city sewers, or diffusion through the trap-water would immediatly pass into the open air;* (*b*) that each soil-pipe should be carried above the roof, the diameter being retained throughout, and there left open or capped by a Wolpert's ventilator, and (*c*) that, to secure ventilation, perforated plates should be substituted for the solid plates which now close the examination shafts on the various drains. These alterations being effected, the trap at the bottom of the soil-pipe will no longer be needed, and should be at once done away with. By providing for the escape of any regurgitation or diffusion of air from the city sewers before passing into the hospital drains, the danger of sewer air pollution of the ward atmosphere from the city sewers will be removed; and by opening the soil-pipes freely at the top, by removing the traps interposed between the bottom of each soil-pipe and the drain, and covering the examination shafts of the drains by perforated plates only, danger of pollution from the hospital drains will, under the system of inspection and flushing followed, become practically inappreciable.

(b.) Water supply

(*b.*) Of the water supply I have but one observation to make. Some doubt was expressed during my inspection of the hospital of the sufficiency of the periodical examination and cleansing of the cisterns used for the water for drinking and cooking purposes. This should have attention.

(c.) Ventilation.

(*c.*) The ventilation of the wards has in several instances been most unfortunately interfered with by buildings added to the original structure, and in every ward (all having been originally designed for ventilation by windows and fireplace) the spaces between the windows and the

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* [Since writing this Minute I have had reason to doubt whether an "examination pipe" rising from the centre of a water-trap affords a sufficiently sure means of escape for regurgitant or diffused sewer air. It is best to provide special means for the escape of such air by the construction of a shaft, freely opening the drain to the outer air on the house (in this case the hospital) side of the trap.—J. N. R.]

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ceiling above and floor below are too great to permit such free change of air in the wards as is wanted. No. 1 ward and the ward above it form parts of a wing, apparently originally designed for two of the largest wards in the building, but which has by the erection of the museum and former dead-house been ruined for ward purposes. On the lower floor a small segment is alone retained as a ward, and that a most unfitting one; a larger segment retained on the upper floor, from the blocking up of certain windows on one side, is hardly more fitting. Again, wards Nos. 2 and 11 on the ground floor have had their ventilation and lighting needlessly deteriorated by the injudicious arrangement of a corridor along an outer side of each. Captain Galton's plan provides for the removal of these corridors, but in the event of any long delay in the execution of that plan it deserves consideration whether the present corridors should not be removed, and others, even if but temporary, erected, which would not interfere with the ventilation and lighting of the wards. I think it would be well to consider whether the museum should not also be removed from its present site and the whole of the hospital wing against which it is placed made again available for wards. The question as concerns the museum will be referred to again presently. With respect to the windows the best plan perhaps would be to carry them nearer to the ceiling above and to the floor below, but other hardly less efficient methods of securing freer ventilation of the wards may perhaps be suggested.

(*d.*) Ward offices.

(*d.*) The ward offices with respect to both the arrangement of the water-closets and the baths are too commonly defective. They require to be examined in detail with a view of cutting off direct communication of water-closets with wards, and of securing a more convenient arrangement of baths. It is well worthy of consideration whether, in view of economising space as well as for sanitary reasons, in some instances, as in the water-closets of the south-western block and corridor, it would not be best to re-arrange and re-build the ward offices.

Laundry.

5. The laundry arrangements should provide for wholly separate dealing with foul and infected linen and ordinarily dirty linen. It should also have attached to it means for disinfecting bedding and linen by heat. Plans prepared by Mr. Boardman fully provide for these requisites. As to the question of site, I am opinion that the site proposed to the north-east of the children's ward and ward No. 11 could not properly be used for this purpose. It is most undesirable to have a laundry in so near contiguity to wards, and it is quite inexcusable that a large drying ground should be placed beneath ward windows. Either the laundry arrangements should be moved into the country, or they should be placed at the further extremity of the ground lately acquired for the hospital.

Out-patients.

6. *The Out-patients' Department.*—The entrance hall of the hospital here forms the out-patients' department. It is impossible that this should be the case without subjecting the interior of the hospital to certain liabilities of infection and of fouling of the air of the wards, which are best avoided. Captain Galton suggests that an out-patients' department should be formed in front of the south-western block of the hospital and of the museum. I would suggest as an alternative plan for consideration, and in view of the removal of the museum and restoration of the south-west block to ward purposes wholly, the transference of the out-patients' department to the opposite block in front. Here, the lower ward being included as a dispensary, it seems to me that the department would interfere less with the existing ward accommodation of the hospital and with projected additions than elsewhere, while

the inconvenience in the position of the dispensary with reference to the interior of the building would be an insignificant evil in comparison with the gain of accommodation in the south-western block.

Museum and dead-house.

7. *The Museum and Dead-house.* — It is objectionable that the museum should be in close communication with wards as at present. On the other hand, it is desirable for pathological work that it should not be dissociated from the dead-house. The site to the north-east of the hospital proposed for the laundry appears to me, if of sufficient area, eminently fitted for the museum, with associated pathological room and dead-house. Here, detached from the hospital but readily accessible, the pathological department and dead-house, in buildings lighted only from the roof, would be inoffensive either to the hospital or to the neighbours, and an incidental advantage, if thought desirable, would be the ability to remove bodies for burial by the side street. It has been objected to this site for the dead-house, that it would necessitate the carriage of bodies through the greater portion of the corridors of the hospital. This objection does not seem to me to outweigh the advantages to be gained; moreover, it has been overlooked that the necessity hardly arises, the site being accessible from all parts of the present and projected building by the garden.

Sanitary supervision and registration.

8. *The Sanitary Supervision of the Hospital, &c.*—The success of the different measures which have been adopted or are suggested for the sanitary improvement of the hospital are dependent for success upon the institution of a proper system of sanitary supervision. Without this the most perfectly constructed and arranged hospital will fail to be wholesome to the patients; with it the evils attaching to original imperfect structural arrangements may be very largely obviated. A fundamental condition in the establishment of such a system is a plan of registration which will show particulars respecting the following matters as they occur:—

(1.) All diseases originating in the wards and hospital generally, distinguishing the infectious from the non-infectious, and the class of persons attacked, whether patients, attendants, or others.
(2.) All cases of infectious disease admitted into the hospital.
(3.) All cases admitted which from any cause may contribute specially to fouling of the wards in which they may be placed.

Without the first requirement it is impossible to gauge accurately the wholesomeness of the wards; without the second and third requirements it is difficult to maintain that control over liabilities to ward pollution and infection which is to be desired.

As a complement to the system of registration here advised, a system of ward registration should be established, which would show at weekly or more frequent intervals the nature of the cases distributed in each ward, with special reference to the question of ward pollution.

Further, a medico-sanitary supervision of the hospital by a responsible officer should be established, preferably by a resident officer. Such supervision would include (*a*) the proper maintenance of the registration above advised; (*b*) the distribution of cases in the various wards with reference to an avoidance of ward pollution; (*c*) the isolation of cases (the distribution and isolation being subject to such general rules as the medical and surgical staff may approve); (*d*) the regulation of all the wards and attendants, with respect to measures of disinfection and of disinfecting processes generally; (*e*) the systematic observation of all things affecting the particular sanitary state of the wards and the

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sanitary condition of the building generally, namely, drainage, ventilation, water supply, food, &c. To meet the requirements as to drainage and water-supply proper detailed plans of the drains and water-pipes (now wanting) should be prepared for reference, and kept in an accessible (in fact, suspended in an appointed) room in the building.

C.

Report by Mr. Netten Radcliffe on the Sanitary Condition of the Royal Infirmary, Manchester.

On the Sanitary Condition of the Royal Infirmary, Manchester, by Mr. Netten Radcliffe.

PRELIMINARY.

The inquiry, of which the results are given in the present Report, was undertaken, by direction of the Local Government Board, in compliance with the following Resolutions of a Committee appointed by a special meeting of Trustees of the Manchester Royal Infirmary and Dispensary:—

13th March 1876.—Resolved, "That the Privy Council [Local " Government Board] be requested to permit one or more of their " medical officers to assist the Committee appointed to report upon " the present condition of the Manchester Royal Infirmary and its " suitability to meet modern requirements in regard to hospital " accommodation, and further to report upon any alterations which " may be thought necessary."

23rd March 1876.—Resolved, "That Mr. Radcliffe [I meanwhile " having been designated as the medical officer who would give the " assistance needed] be asked to report—

" 1. As to the salubrity of site in reference to the Infirmary " requirements:

" 2. The sanitary condition of the hospital, including the drainage:

" 3. The suitability and adaptability as regards construction and " accommodation, and further to report generally upon any " [medical] points included in the Resolution under which the " Committee was appointed."

The inquiry here contemplated rendered necessary, in the first place, as lying at the foundation of the several subjects named, an investigation of the success or unsuccess of treatment of patients in the Infirmary, so far as this might be influenced by its structural arrangements or general administration; and next, in the event of any disclosed medical or surgical unsuccess, the determination of the particular defects of structure, or of administration, or of both, which might have contributed to it. The investigation of the first of these questions had to be restricted partly from the limited time at my disposal, but mainly from the insufficiency, for my purpose, of the Infirmary records, to certain cardinal matters relative to the development and dissemination of infectious diseases of a particular kind in the wards. The diseases here referred to are those which are apt to originate and spread in the surgical wards of ill-arranged and ill-kept hospitals, namely, erysipelas, gangrene, and the various local mischiefs and suppurative and septic conditions of the system having their beginning in putrefactive changes occurring in wounds and other injuries ("pyæmia," "septicæmia," &c.). These diseases are conveniently described under the common name *traumatic infections*, and their prevalence or liability to recurrence forms the most obvious indication either of inherent fault of site or construction, or of faulty

App. No. 5.

HOSPITAL HYGIENE.

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management. But even with regard to these diseases the Infirmary records are neither full nor precise; and the data I have got together respecting them as occurring in the wards, although perhaps sufficient to satisfy the immediate practical purpose of the inquiry, do not enable me to discriminate so clearly as I could have wished the respective influence of the several conditions which contribute to their prevalence thère.

In conducting the inquiry I have been aided by the counsel and co-operation of the medical staff. Indeed, the questions submitted to me had already been considered and reported upon by the medical staff, and their report (24th May 1875), with other papers for my information, was placed in my hands at the beginning of the inquiry. The conclusions of the medical staff in this report had been governed chiefly by their familiar and continuous experience of the progress of cases in the wards. But in the inquiry entrusted to me, I having no previous knowledge of the Infirmary, it was desired, with the concurrence of the medical staff, that I should examine the questions submitted to me independently, and that I should endeavour to elucidate them by the data to be gathered from the Infirmary records, and from a personal inspection of the building and its precincts. In other words, I had to substitute for that large and intimate knowledge of the Infirmary in its medical and surgical relations possessed by the medical staff such written and observable data as were open to a stranger. Hence the sufficiency of the Infirmary records for the purpose of the inquiry became, in the first instance, of prime importance. I shall have occasion to recur to this subject more than once in the course of my report, for it touches a question of hospital administration of great practical moment, namely, the system of recording cases admitted for treatment and their results, which is illustrated by the inquiry.

THE ESTABLISHMENT OF THE INFIRMARY IN 1753 AND SUBSEQUENT HISTORY.

I. The Manchester Royal Infirmary—also Dispensary, Lunatic Hospital and Asylum, and Public Baths—was established in 1753. In the beginning the charity included these several institutions, and with the exception of the public baths, given up in 1847, it still includes them. The present Infirmary has grown by successive developments out of a building erected on the same site, which was opened in 1755 as a hospital for the reception and treatment of "such diseased "and wounded persons as were from indigent circumstances unable to "supply themselves with medical assistance, as a lunatic asylum, and "as a dispensary for the relief of indigent sick at their own homes." The medical history of the growth of the building is instructive with reference to the present inquiry.

Beginning of the sanitary history of the Infirmary, 1838. Overcrowded and unwholesome wards.

The number of beds contained in the Infirmary, as originally constructed, does not appear from the papers to which I have had access, but in 1801–2 the building was enlarged so as to admit of an addition of 60 beds; and in 1834–5 the number of beds available for patients was 178. It is not until 1838 that the books of the Infirmary begin to yield information as to the state of the wards. Early in that year "great inconvenience" was experienced from the crowded state of the wards, "particularly from the number of double beds frequently used;" and the Medical Committee, in answer to a communication from the Weekly Board on this subject, suggests "the necessity of three or four additional spacious wards," adding, that if these wards were in an isolated and airy situation the committee believed that they would prove more beneficial. The committee also remarked that applications for the admission of very urgent cases were constantly on the increase. Incidentally light is thrown upon the condition of surgical cases in the Infirmary in 1838, from a minute made early in 1839 by the Medical Committee on a question of dry-rubbing the floors of the wards and lobbies. At a

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Prevalence of erysipelas in wards, 1838.

monthly consultation on the 4th April that year, a letter was read from the house surgeon relative to the state of the surgical wards after two months' practice of cleansing the floors of the wards and lobbies by dry-rubbing, and he states that "for some time" before this practice was adopted "almost every operation that was performed was followed by " more or less severe attacks of erysipelas, and the mortality amongst " these cases was very great." But since dry-rubbing had been practised "only one case of erysipelas following accident or operation had " occurred in the hospital; and the aspect of wounds of all kinds, from " the slightest to the most severe, had also materially improved."

Erysipelas, 1840.

The next year (1840) there was a recurrence of erysipelas in the wards, determined it was believed by an unauthorised resumption of the discarded practice of cleansing the floors by washing. The necessity of persisting with dry rubbing was urged by the Medical Committee; but three years afterwards (1843) the state of the wards appears to have become so unsatisfactory that the Weekly Board requested the Medical Committee (5th October) to inspect the wards as to the sufficiency of ventilation, "with the least delay possible," and to suggest requisite alterations.

In 1845 the necessity for enlarging the Infirmary was seriously considered by the Trustees (who had been incorporated in 1842); and at a general meeting held on the 26th June of that year, action was taken for "accomplishing so indispensable a measure." The chairman (Mr. Thomas Markland), in stating to the meeting the reasons which rendered an enlargement of the building necessary, said :—

"For a considerable number of years no addition had been made to it, " further than in 1841, when 14 beds were added. The number of beds " was only 192, 67 for medical and 125 for surgical patients. Consider- " ing that almost every week some patients were sent away in conse- " quence of there being no room a further extension of beds was " extremely desirable. The medical gentlemen would state that 67 beds " for the medical patients were sadly too few; and they had been " repeatedly obliged, in the case of Manchester patients, who might " have been properly admitted into the house, to make them home- " patients, as those who came from a distance from the out-towns were " invariably admitted in preference. Then the immense number of " accidents that were continually occurring, and which were brought " here, and must be admitted without any recommendation from a sub- " scriber, made the number of surgical beds likewise sadly too small ; " and considering the amazing increase of the population since any " increase had been made in the size of these buildings they might " safely conclude that they ought not to go on as at present. The " house apothecary and house surgeon were frequently obliged to report " that the house was very much crowded, and at times unhealthy. The " wards were too full, and if they got an increase of room they wished " to remove part of the beds in the institution into more airy wards. " Another thing was extremely hurtful to their feelings, but which they " could not help at times; from the number of patients, and particularly " of accidents, it was absolutely necessary to put two in a bed; and on " the 10th February they had actually 14 double beds, and 28 patients " lying together, which was extremely improper."

It would appear, moreover, from references in other parts of the chairman's statement, and from a speech made to the meeting by Mr. Richard Birley, that doubts were then entertained as to the suitability of the site occupied by the Infirmary.

Enlargement of Infirmary.

The Infirmary and Dispensary, in conjunction with the Lunatic Hospital, then (1845) formed a single oblong block of buildings, of which so

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Removal of Lunatic Hospital to Cheadle, 1848.

Opening of South Wing, 1848.

Opening of North Wing, 1851.

Union of House of Recovery with Infirmary, 1852.

Completion of present Infirmary, 1853-4.

much as was retained in subsequent alterations constitutes the central portion of the present Infirmary and Dispensary. As a result of the movement set on foot in 1845, a lunatic hospital was built in the environs of Manchester, at Cheadle, to which the insane patients under treatment in the old building were removed in 1848. The same year the South Wing of the Infirmary was completed and brought into use; and three years afterwards (in 1851) the North (Jenny Lind) Wing; the area around the Infirmary being, during this period, fully opened out and placed in the condition it now retains. In 1852 the Manchester House of Recovery (or house for the reception and accomodation of persons sick of fever) was united with the Infirmary and Dispensary, and in 1855 wards were appropriated in the Infirmary for the reception of "fever" patients in accordance with the terms of the union. In 1853–54 the dome was added to the Infirmary, and the building, as it now appears externally, completed. At this date there were in the wards 277 beds for the reception of patients, of which 57 were reserved for cases of "fever," and the number of resident officers, nurses, and servants probably was the same as that given in a return four years later (1858–59), namely 85.

Extreme unhealthiness of surgical wards, 1853.

By the additions of the North and South wings to the Infirmary it had been designed to augment the number of beds for patients from 191 (the number in 1845) to 350. But in this proposed large increase it was contemplated not to give to each bed more than 800 cubic feet of ward space. On reconsideration of this question it was decided that each bed should have from 1,000 to 1,200 cubic feet of ward space. This decision, besides rendering necessary a rearrangement of beds in the older portion of the Infirmary, diminished the supposed available ward space in the newer portion, and thus rendered necessary a reduction of the proposed bed accommodation in the wards to 277. In other words, instead of 159 beds, only 86 were obtained by the enlargement of the Infirmary. Notwithstanding this increased number of beds and the larger ward space given to each bed, two years after the completion of the North Wing the surgical wards became so "extremely unhealthy" that the Medical Committee had to call the attention of the Weekly Board to the fact, "in order that, if possible, some means might be devised to remedy the great evil."* The wards here referred to included, I believe, the new wards in the north wing which had not been fully two years in use.

Conversion of South Wing into a fever hospital, 1853.

While this state of the surgical wards was in process of development, and during its prevalence, the question of giving effect to the arrangement by which, the previous year (1852), the House of Recovery had become united with the Infirmary came under the consideration of the Trustees. At first it was proposed to build a new fever hospital at the rear of the Infirmary, but in deference to objections of the Town Council, and of numerous subscribers to the charity, this project was set aside, and a plan approved of which some of the results came under observation during the present inquiry. In accordance with this plan a portion of the South Wing was converted into a fever hospital, intended originally for 50 patients, but actually arranged so as to yield bed accommodation for 57. To prevent the sacrifice of a corresponding number of beds for the general purposes of the Infirmary the room within the dome, certain garrets, and the sunk basement storey of the South Wing (from which the laundry was removed for the purpose) were converted into dormitories for nurses and servants, 38 in number, who had previously occupied rooms in the body of the building. The dormitories constructed in the basement storey of the South Wing did not, at the time of their construction, meet the limited requirements of the Public Health Act, 1848, as to cellar dwellings, and they do not now meet the like requirements of the Public Health Act, 1875. By the arrangement here described, and which, in effect, crowded, if it did not overcrowd, all the available bed space in the building, it was found practicable to retain, ostensibly at least, the full complement of beds for surgical and medical cases, irrespective of the wards and beds set apart for the fever hospital.

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* Monthly consultation (Medical Committee), 1st December 1853.

Unhealthiness of surgical wards, 1855.

Pending the completion of the above-mentioned changes, the condition of the surgical wards appears to have gone from bad to worse, and in December 1855 a sub-committee was appointed to inquire into the sanitary condition of the Infirmary. This sub-committee, in March 1856, reported to the following effect:—They had found the ventilation of "the house" defective in several particulars. Especially it was instanced that a ventilation shaft from the dead-house, which passed through the surgical wards for women, communicated by several accidental apertures with those wards, as was shown "experimentally," and "by the additional evidence of foul smells at the parts referred to." The drainage of the Infirmary was described as "good and unexceptional," except certain iron pipes into which the waterclosets and slop-sinks opened, and which below were connected with the drains without the intervention of a trap, and above were carried into the spaces within the roof, where they opened beneath partially closed man-holes. Through these pipes, which were seven in number, "ascending currents of gas continually circulated," and "fetid steam could be seen" coming from them, while the roof spaces, which communicated freely by sundry large apertures with the upper lobbies, and through them with the wards, were pervaded with "a penetrating and sickly odour." Finally, the committee reported that greater "facilities were needed for washing, " drying, and purifying bedding, bed-ticks, &c., that have contracted " impurities." The graver defects of ventilation and of internal drainage arrangements were presumably remedied immediately upon their discovery by the sub-committee, and the measures thus adopted are stated to have been followed by "a marked diminution of sloughing " sores, and more rapid and complete recovery after surgical operations, " and a diminished mortality."

Unhealthy condition of wards, 1857.

This improvement in the state of the wards appears, however, to have been but transitory, notwithstanding the measures which were adopted for removing the various sanitary defects described by the sub-committee. For the next year (1857) the unhealthy condition of some of the wards, and particularly of the surgical wards for men, again formed a subject of serious consideration for the Weekly Board and the medical staff. The medical staff reported that, in view of removing "the poisonous influence" which affected the wards, "attention must still be directed" to the following points, namely, "the greatest cleanliness in the use of " sponges and dressings; the cutting off communications between the " waterclosets and the wards; the securing of dryness by fires and dry- " rubbings; wider separation of the beds, including removal of the " infected to a distinct ward; and an extension of through and through " ventilation."*

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* Special consultation (Medical Committee), 13th August 1857.

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In the annual report for 1857–58 the Trustees express their regret that they should be "compelled, for want of room, to refuse admission to many who require medical and surgical assistance."

At the period now under review the unhealthiness of the wards was attributed, in part, to seasonal influence. Thus, the Medical Committee describing the unwholesomeness of the wards in August 1857, remarks also that the wounds in many cases of accident, treated as out-patients, were "in a more unhealthy state than usual," and observes that "such a condition has not unfrequently been observed at this period of the year." Again, in June of the following year, 1858, the Medical Committee reports that in the surgical wards "some of the wounds have a tendency to take on sloughy action," and attribute this to a "sudden increase of the temperature."

Continuing unhealthiness of wards, 1861.

Much as had been done to this time to improve the sanitary condition of the Infirmary, by better ventilation, lessening the number of beds in the several wards, rectifying certain defects of drainage, and generally by an amended ward administration, it appeared to have been done to little purpose. For in 1861, in consequence of the continuing unhealthiness of the building, it became necessary to institute another examination into its state, and a medical sub-committee was appointed for the purpose. The report of this sub-committee, dated the 29th April 1861, is of considerable importance with reference to several questions which have to be considered in the course of the present report. It consists mainly in a series of recommendations, and is divided into two parts, the first relating to certain structural changes in the building, which the sub-committee held to be desirable; the second, to certain matters of administration. Under the first head the sub-committee recommended that the number of waterclosets in the building should be reduced one half, and that those only should be retained which are in the rear of the Infirmary. With respect to the latter, moreover, they recommended, further, that the closets should be removed from the body of the building, and placed in projections to be built in rear of the wings and central block, and which would admit of cross-ventilation of the closets. Next, in view of certain contemplated changes, to be noted presently, which would occasion a reduction in the number of beds, the sub-committee recommended that three tiers of wards, each to contain "about ten beds," should be constructed on "the pavilion principle," behind and communicating with the central block at its middle. Other recommendations, involving structural alterations, referred to the conversion of some of the smaller wards into larger wards by removing the partitions between them, to certain changes of windows, and to the opening and widening of apertures between the wards and lobbies so as to secure more effective ward ventilation. Under the second head of the report, the sub-committee stated that measures previously recommended for the purification of soiled horse-hair mattresses had been "altogether neglected," and that such measures as had been executed "had become additional sources of pollution when the mattresses were next exposed to accidental wetting." They stated also that the rules of the house as to the cleansing and changing of bed linen and blankets did not meet necessary requirements of cleanliness, especially in the surgical wards, and that certain metal articles of ward furniture were objectionable from retaining foul smells, notwithstanding careful cleansing. The sub-committee advised the correction of these errors, and then proceeded to express the opinion that the "small and dark" surgical ward under the east portico was "unfit for constant occupation," and to recommend its disuse except for occasional

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purposes. The question of cubic space in the wards relatively to the number of beds was next considered, and a recommendation was made for a rearrangement of beds in the surgical wards and their diminution by 8, so that to each bed there might be given 1,435 cubic feet of ward space, *instead* of 1,200 as heretofore. Finally, the sub-committee recommended an experimental trial of painting the walls and varnishing the floors of some of the surgical wards, instead of the whitewashing and dry-rubbing then in use.

If the recommendation of the sub-committee as to the disuse of the small surgical ward under the portico had been adopted, the total loss of beds involved in the suggestions made, it is stated, would have been 10—the total beds available for patients in the Infirmary, according to this scheme, being 231. To meet the loss of beds, as well as, to some extent, the insufficiency of the accommodation for patients in the Infirmary, the sub-committee recommended the construction of the three additional wards, as already described.

From this report we learn that the original structural arrangement of the Infirmary, in several important respects, was now conceived to be probably exercising an injurious influence upon the patients treated in it; that there was still a great want of nicety in the general management of the wards; that the surgical wards, at least, were overcrowded, and that to relieve this overcrowding it would be necessary to sacrifice several beds, although by so doing difficulties arising from the insufficiency of the accommodation for patients to meet the calls upon the Infirmary would be increased.

The suggested structural changes in the Infirmary were referred to the architect (Mr. Waterhouse), and his report upon them (of which a copy does not appear to have been kept among the Infirmary records) was submitted to a special meeting of the medical staff on the 13th June 1861, at which the architect appears to have been present. This meeting approved of the recommendations of the sub-committee for the removal of the waterclosets, and of certain alterations for increasing ward space and ventilation; it approved also a plan of the architect's for the reconstruction of the staircases, and suggested, moreover, the removal of the ceilings, and exposure of the girders in the lobbies, as also the removal of the dead-house, post-mortem room, poultice room, and ashpit to a greater distance from the wards.

The different recommendations made by the medical sub-committee and the medical staff appear to have been generally carried out, with the exception of the removal of the waterclosets and the sacrifice of beds. Three closets were abolished, but the remainder were kept within the body of the building, where they still remain.

State of Infirmary, 1863. Dr. Bristowe's and Mr. Holmes' visit.

In 1863 the Infirmary was visited by Dr. Bristowe and Mr. Holmes, in the course of the inquiry conducted by them for the Privy Council, and as instructed by its medical officer, Mr. Simon, concerning the sanitary circumstances of the hospitals of the United Kingdom.* In this report we learn the results of the changes effected in the Infirmary since 1861, as they appeared to these observers. "The corridors," they say, "are spacious and well ventilated, and have from their peculiar "formation a window at each end. And besides this, they have free "communication with the wards, and have four staircases leading from "them . . . The ventilation of the wards seemed to us exceedingly

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* Sixth Report of the Medical Officer of the Privy Council, 1863. *Appendix*, p. 614.

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"good; the only wards in which there were any appreciable defects "were those situated under the porticoes; these were acknowledged to "be somewhat stuffy, and seemed so to us. . . . . . Both walls "and ceilings (of wards and corridors) are painted, and the floors are "oiled, but also scrubbed. The hospital is cleansed thoroughly once a "year. The waterclosets are well drained, ventilated, and altogether "unobjectionable. They communicate with the corridors and not with "the wards, and are well separated even from the former. The hospital "has been in its present condition for three years only; prior to that "time the corridors were much more confined and close; the wards, too, "were without any means of ventilation beyond that supplied by the "open fireplaces, the doors, and the ordinary sash-windows; the walls "were whitewashed and the floors scrubbed in the usual way, and the "waterclosets communicated with the wards. The prevalence of "hospital diseases up to that time, and especially just before it, led to "the changes which have been made. . . . . We are informed "that erysipelas and pyæmia are very common, and that these diseases "were especially common about three years, or rather more, since."

No arrangements had been made for the isolation of cases of traumatic infections occurring in the surgical wards at this time, for Messrs. Bristowe and Holmes note observing in those wards "a case of "erysipelas, and one of diffuse inflammation (both admitted for the "diseases specified), and two cases of traumatic gangrene, both of which "had originated in the hospital." They also note observing two cases of erysipelas among the patients in the medical wards.

Although Dr. Bristowe and Mr. Holmes were of opinion that the mischiefs liable to arise from the radically defective position of the waterclosets had, so far as could be ascertained by a passing inspection, been apparently fairly counteracted by their free ventilation and disconnection with the wards, the Medical Committee, in June 1863, had held it necessary to remind the Weekly Board of the recommendation of the sub-committee and of the medical staff in 1861 for the removal of the waterclosets from the body of the building, and to urge that effect should be given to this recommendation, as also to the recommendation, made at the same time, for the removal of the dead-house. The same year (December) the question of appointing a trained lady head-nurse to reorganize the nursing arrangements of the hospital was discussed by the Medical Committee.

A period is now arrived at when we obtain some more definite, although still very inadequate, information as to the sanitary condition of the wards. We have it in evidence that the internal state of the Infirmary had been for many years a subject of continual and anxious attention on the part of the Trustees and the medical staff, and that original faults of construction, so far as they affected ventilation and the more obvious internal drainage arrangements, had been so successfully remedied as to meet the approval of observers as experienced as Dr. Bristowe and Mr. Holmes. It is to be assumed, moreover, (in the absence of detailed statements) that the various recommendations of the medical staff for the improved administration of the wards, with the exception of the isolation of traumatic infections, and, perhaps, also the diminution of the number of beds in the surgical wards, had been carried into effect. Notwithstanding these great changes the surgical wards were "unhealthy" during five months of 1863, and two months of 1864; and in the autumn of 1865 "several cases of sloughing" were reported, apparently a slighter form of hospital gangrene, and the begin-

Unhealthiness of wards, 1863–64, of and prevalence hospital gangrene, pyæmia and erysipelas 1865–68.

ning of an outbreak of that disease which affected the wards in the two following years. In 1866 there were noted in the surgical wards 21 cases of pyæmia, of which 13 were fatal, also cases of "sloughing" and "phagedæna" (in other words, I take it, hospital gangrene) in June, September, and November, "several cases" in each of the two latter months. Four of the deaths from pyæmia happened in December, when the surgical wards were stated to have been "very unhealthy." The next year, 1867, was one of the unhealthiest in the annals of the Infirmary. During five months of the year, January, February, March, May, and June, "hospital gangrene" was present in the surgical wards, part of the time with pyæmia and erysipelas; and of pyæmia 15 cases were recorded, 10 fatal, distributed throughout the several months of the year, except June and October. In 1868 eight cases of "sloughing" and one of "hospital gangrene" (July) were recorded in the surgical wards; also three fatal cases of pyæmia and two cases of erysipelas. After this year "hospital gangrene" seems to have disappeared from the wards.

While this large prevalence of hospital maladies in 1865–68 seemed to show that the measures which had already been adopted to obviate the unhealthiness of the surgical wards had been unsuccessful, other measures were in progress, part designed to still further remedy original faults of construction and defects of administration, part to relieve the great and increasing pressure upon the accommodation for patients. Of measures of the first sort, some related to a diminution of the number of small wards in the Infirmary by removing the partitions between them and converting them into larger wards, to the better ventilation and lighting of the corridors, and to improved arrangements for washing linen. Of measures of the second sort, two were instituted of incalculable importance, one the establishment of a convalescent hospital, the other the establishment of a detached "fever" hospital. The "Barnes Convalescent Hospital," in connexion with the Infirmary, and having then accommodation for 34 patients, but now for 140, was opened in 1867; the "Fever" Hospital at Monsall, also in connexion with the Infirmary, was opened in 1871, with accommodation for 84 patients, since increased to 130. By the opening of these two associated hospitals the accommodation for patients ordinarily at the command of the trustees was well-nigh doubled; and the "fever" patients having been removed from the south wing of the building to the Monsall Hospital, the wards which had been set apart as a House of Recovery were restored to their original use. The increased ward space thus gained for the general purposes of the Infirmary was used mainly for an augmentation of the number of medical beds, partly for a better distribution of the surgical beds, so as to give each bed larger ward-space.

Opening of the Barnes Convalescent Hospital, 1867.

Opening of the "Fever" Hospital, Monsall, 1871.

In the interval between the opening of the Barnes Convalescent Hospital and the Monsall Fever Hospital (1867–71), and during the two years following the opening of the latter hospital (1872-73), the Infirmary appears, so far as the records show, to have been comparatively free from hospital maladies; but in 1874 another period of ward unhealthiness commenced, hardly, if at all, less serious in its character than previously recorded periods of unhealthiness. Towards the close of 1874 the surgical wards having been more or less "unhealthy" since June of that year, but in what particular way is not stated, erysipelas became common in them. This malady continued prevalent in these wards during 1875, and to the time of this inquiry in June 1876, and it appeared also to some extent in the medical wards, and in the ward especially reserved for diseases of women, under the charge of the

Unhealthiness of wards, 1874.

TABLE I.—SHOWING the REGISTERED CASES of TRAUMATIC INFECTIONS occurring in th
to the 12th of June 1876; also the Distribution

YEAR.	Registered Cases of Traumatic Infections.			SURGICAL					
	Pyæmia.	Septicæmia.	Erysipelas.	PRESIDENT. Beds, 14. Cubic space per Bed, 1,522. Accident (Male).	JENNY LIND. Beds, 18. Cubic space per Bed, 1,353.	TREASURER. Beds, 14. Cubic space per Bed, 1,315. Accident (Male).	JOB HINDLEY. Beds, 14. Cubic space per Bed, 1,171.	HUMPHREY NICHOLS. Beds, 18. Cubic space per Bed, 1,491.	DAUNTESEY HULME. Beds, 10. Cubic space per Bed, 1,476.
1875.									
January - -	—	—	1	—	—	—	—	—	—
February - -	—	—	2	—	—	—	—	—	—
March -	—	—	1	1	—	—	—	—	—
April -	—	—	2	1	—	—	1	—	—
May - - -	—	—	2	—	—	1	—	—	—
June -	—	—	1	1	—	—	—	—	—
July - -	—	—	—	—	—	—	—	—	—
August - -	—	2	2	1	1	—	1	—	1
September - -	—	—	4	—	1	1	—	1	—
October - -	—	1	7	—	3	—	1	—	1
November - -	2	—	6	1	—	3	—	1	—
December - -	—	—	8	4	—	—	1	2	—
1876.									
January - -	1	—	10	1	3	1	1	1	1
February - -	—	—	2	—	—	1	—	1	—
March - -	—	1	6	1	—	1	1	1	1
April - -	—	—	2	—	—	—	—	—	1
May - -	—	—	6	1	1	—	—	—	1
June to the 12th -	—	—	3	1	—	—	1	—	—
Total registered -	3	4	65	13	9	8	7	7	6
Cases ascertained from other sources -	—	—	5	—	—	—	—	—	2
Cases in Medical Wards.	—	—	6	—	—	—	—	—	—
Total Cases ascertained.	3	4	76	13	9	8	8	8	8
Total Deaths ascertained.	7	1	34	—	—	—	—	—	—

Surgical Wards of the Infirmary, and the Months in which they occurred during 1875 and of the Cases in the various Wards.

WARDS.											
ALICE. Beds, 11. Cubic space per Bed, 1,430. Accident (Female).	MOSLEY. Beds, 12. Cubic space per Bed, 1,446.	ALBERT. Beds, 5. Cubic space per Bed, 1,795.	ALEXANDRA. Beds, 10. Cubic space per Bed, 1,239.	WHITE. Beds, 4. Cubic space per Bed, 1,423.	BYROM. Beds, 4. Cubic space per Bed, 1,406.	PEEL. Beds, 4. Cubic space per Bed, 1,499.	LOUISE. Beds, 4. Cubic space per Bed, 1,230.	HALL. Beds 5. Cubic space per Bed, 1,291.	DERBY. Beds, 7. Cubic space per Bed, 1,163.	DALTON. Beds, 4. Cubic space per Bed, 1,766. (Eye).	HATTON. Beds, 7. Cubic space per Bed, 1,165.
—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	2	—	—	—	—	—	—	—
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2	—	—	1	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	1	1	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—
—	2	—	1	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—
6	5	2	3	2	1	1	1	—	—	—	—
—	—	1	—	—	2	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
6	5	3	3	2	3	1	1	—	—	—	—
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Prevalence of erysipelas and other hospital maladies, 1874–76.

obstetric physician. According to the Infirmary register, three cases of pyæmia, one of septicæmia, and 11 cases of erysipelas, originated in the surgical wards, in 1874; two cases of pyæmia, three of septicæmia, and 36 cases of erysipelas, in 1875; and one case of pyæmia, one of septicæmia, and 29 cases of erysipelas from the 1st January to the 12th June inclusive of the present year, 1876. (*See* Table I. and Note I.). These figures represent imperfectly, as all the figures previously quoted, the actual incidence of the several hospital maladies referred to in the surgical wards, and they do not include the instances occurring in the medical wards and the obstetric physician's ward. No systematic record, as previously stated, has been kept of the diseases referable to circumstances peculiar to the hospital originating within the wards, and as a rule, and this not invariably, only the more serious examples have been entered in the register. Thus five cases of pyæmia and septicæmia were registered in 1875, but the pathologist's book shows that *seven* fatal cases were removed that year from the wards to the dead-house. Again, 29 cases of erysipelas are entered in the registers from the 1st January to the 12th June 1876, but the reports of the house surgeon to the Weekly Board and Medical Committee show that 34 cases at least had occurred during this period. Moreover, no record of three or more cases taking place in the medical wards, and of four cases of peritonitis, all fatal, and unquestionably of erysipelatous origin, following upon tapping for ascites in the obstetric physician's ward, appears either in the registers or in the minutes of the Weekly Board or of the Medical Committee.

The total number of cases of erysipelas ascertained during the inquiry to have occurred during 1875, and to the 12th June 1876, was 76; the total fatal cases ascertained was 34. This latter number, large as it is, does not include the whole of the fatal cases; for the register at the Monsall Fever Hospital, to which many of the cases were removed, is not arranged so as to admit in all instances of the cases of erysipelas taken there from the Infirmary, and which had contracted the disease in the wards, being distinguished. But the extreme gravity of the fact of not less than 34 fatal instances of erysipelas contracted within the walls of the Infirmary, within a period of hardly eighteen months, would hardly be enhanced by the addition of a few units.

CONDITIONS DETERMINING THE CONTINUOUS UNHEALTHINESS OF THE INFIRMARY.

II. I have now, with such precision as the data admitted of, brought this brief outline of the sanitary history of the Infirmary to a conclusion. It shows that the many consecutive measures which have been adopted to remedy faults of construction, to improve the ward administration, to obviate crowding, to meet more amply for the calls upon the charity, and latterly to isolate the sick from traumatic infections, and, I may add here, to obviate these infections by special surgical (as, for example, "antiseptic") treatment, have all failed to remove that liability to the recurrence of hospital maladies within the wards, in frequent serious outbreaks, which has attached to the Infirmary from the earliest available records of its sanitary condition to the present time. I shall endeavour in this report to show (always it must be understood within the limits of the imperfect data at my command) what are the circumstances which have frustrated the efforts made to render the Infirmary at all times wholesome to the sick and injured treated within its walls, distinguishing such as are inherent to the construction of the building from those which are dependent upon errors of administration.

Prevalence of erysipelas in Manchester. 1874-75.

Before entering upon the consideration of these circumstances, it is necessary to note the fact that the recent and still unended prevalence

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Hospital Hygiène.

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of erysipelas in the Infirmary appears to have concurred with unusual prevalence of the disease in the city, although no exceptional mortality from it is shown in the death registers.* The relation of recurring outbreaks of traumatic erysipelas in surgical wards to epidemic erysipelas among the outside community does not appear to have received that attention which it deserves. It involves questions of much interest, as well etiological as practical. There is good reason to believe that an external origin is very frequently to be assigned to the occurrence of erysipelas in surgical wards. A danger of this kind is at all times present among large urban populations, although the risk of such danger is greater at one time than another, varying with the external conditions provocative of erysipelas. But for any purpose of hospital administration this risk needs to be regarded as a constant element in the case, and the business of the hospital is to reduce to the smallest possible point, by precautions directed to the arrangements of the hospital itself, the opportunity of mischief consequent upon introduction of the infection from without. Thus any extension of erysipelas in a ward, following upon such introduction, should be looked upon to that extent as a failure of administration. I was desirous to have eliminated the part played by infection from outside in the recent prevalence of erysipelas in the surgical wards of the Infirmary, but here again I was foiled by the insufficiency of the data for the purpose. Since the opening of the

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* TABLE II.—MANCHESTER.—ERYSIPELAS, &c.

Year.	Deaths in Registration District of Manchester.	Returns of Manchester and Salford Sanitary Association.	Admissions to Infirmary.†			Remarks.
		Erysipelas.	Erysipelas.			
	Erysipelas.	Cases in Public Practice.	In-patients.		Home Patients.	
			Medical.	Surgical.		
1866 - -	31	316	7	4	40	
1867 - -	15	290	6	13	14	
1868 - -	22	308	2	12	14	
1869 - -	22	269	13	4	30	
1870 - -	26	387	12	7	31	1871. Monsall Fever (Infectious Diseases) Hospital opened. 1873. Attendance upon home-patients was first given (this year) by a medical staff having no duties in the Infirmary wards (surgical), as was previously the case.
1871 - -	23	245	5	7	21	
1872 - -	27	284	11	3	28	
1873 - -	29	From July 5 to Dec. 31. 144	3	2	23	
1874 - -	26	602	4	7	59	
1875 - -	21	539	23	30	58	
1876 - -	—	To 3rd June 185	No return.			

† After the opening of the Monsall Hospital, 1871, cases of recognised erysipelas from outside were sent there, but they are recorded among the admissions in the common register of the Infirmary, and are included in the above Table.

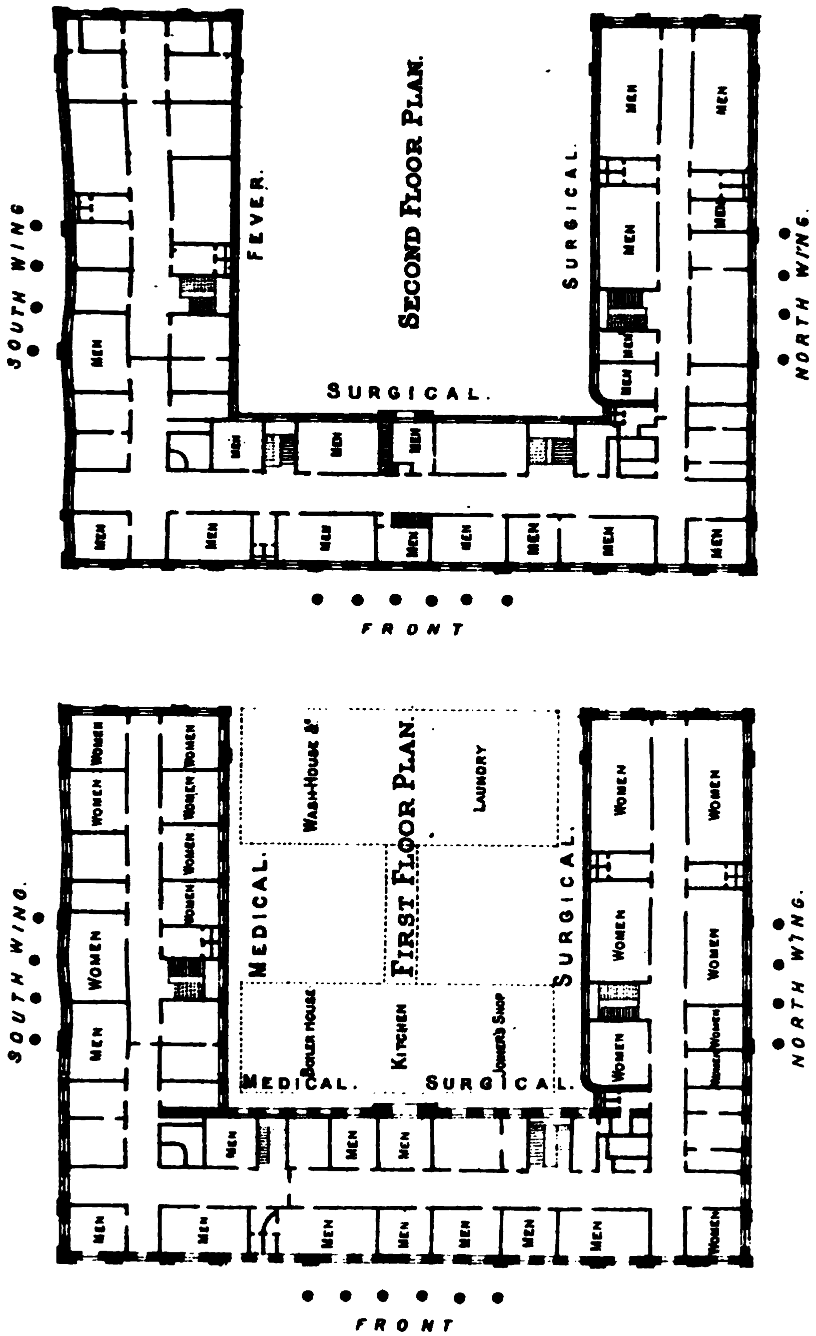
Monsall Fever Hospital in 1871, all cases of declared erysipelas brought to the Infirmary have not been received there, but have been sent direct to Monsall; and to this important extent the danger under consideration has been diminished. But of the cases of erysipelas, traumatic and other, treated in the Infirmary, which had certainly or probably contracted the infection before admission, no record has been kept. The want of information on this point, although to be regretted, will perhaps hardly affect the broad practical issues of the inquiry upon which I now enter, preceding the discussion by a general description of the Infirmary.

General description of Infirmary.

The Royal Infirmary stands well in a large open space, which is isolated from neighbouring buildings by busy and noisy thoroughfares. This site, when the Infirmary was first established, was on the outskirts of the city as it then existed, but it is situated in the heart of the city as it now exists. The building is formed, as already described, of a central block and two wings, the latter being thrown back at right angles from the extremities of the central block. Within the area in rear of the building, and enclosed on three sides by it, are placed, below the level of the ground, in excavations sunk even lower than the basement story of the main building, the kitchen and its subsidiary offices, the boiler-house, the wash-house and its appurtenances, and other offices. The main building, in addition to a sunk basement, has three stories, and throughout it has been constructed on a uniform plan. (*See* Plans.) A central corridor, continuous from the wings to the central block, traverses longitudinally each floor, and from it open, on either side, the different wards and other rooms. The several floors are connected with each other by capacious well-lighted staircases, which can be placed in direct, and are almost invariably in free communication with the outer air through the windows on the various landings. The first and second floors are also in direct communication by means of openings cut through the ceiling of the corridor of the first floor into the corridor above, as well for light as for ventilation. The upper corridor is lighted from its roof, and has there communications with the outer air. At the junction of each wing with the central block, and in the centre of the building there, a shaft containing a large hoist, and communicating with each floor, runs from the basement to the upper story. In the basement of the main building, below the ground-level, are the dead-house, the post-mortem room, the still-rooms of the dispensary, the principal store-rooms, the dairy, the nurses' dining-room and servants' hall, the rooms of the storekeeper and housekeeper, and bedrooms for 39 porters, servants, and nurses. On the ground floor are the administrative offices, the rooms of the medical staff and the dispensary rooms, the latter with the accident room occupying the whole of this floor in the north wing. The first and second floors contain the wards (29 in number, *see* Plan II.), with the addition of the sisters' rooms, the rooms of the principal nurses, the chapel (which occupies part of both floors), and the operating room (on the second floor). Above the second floor, the rooms within the base of the dome, the space within the pediment of the east (front) portico, and a garret in rear of the dome, have been converted into dormitories for 15 nurses (four in the dome, seven in the pediment, and four in the garret). The wards differ considerably from each other in their dimensions. None exceed 20 feet in width, and of several the width is only 18 feet. The cubic space per bed in the different wards (the distribution of the beds having been chiefly governed by this consideration) ranges from 1,000 cubic feet or thereabouts to 2,000; in the principal wards from 1,200 to 1,500. (*See*

Plan I.

To illustrate Mr Netten Radcliffe's Report



MANCHESTER ROYAL INFIRMARY:
1863.

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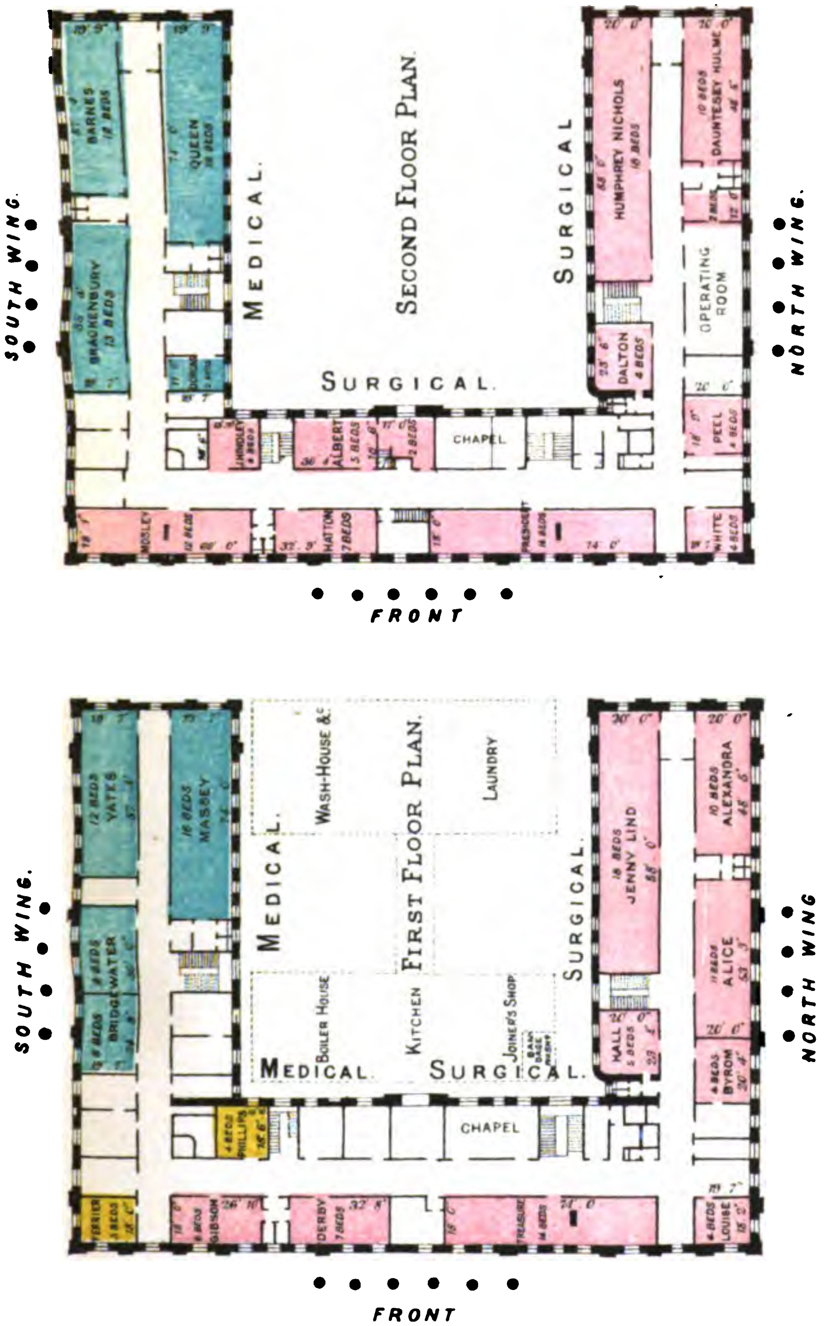
ASTOR, LENOX AND
TILDEN FOUNDATIONS

Plan II

To illustrate Mr Netten Radcliffe's Report



MANCHESTER ROYAL INFIRMARY.

JUNE 1876.

Medical Wards, coloured BLUE; Surgical Wards, RED; Erysipelas Wards, YELLOW.

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ASTOR LENOX AND
TILDEN FOUNDATIONS.

Table III.) Ventilation of the wards is effected by the aid of the windows, of open fireplaces, and of large apertures near the ceiling between the wards and the corridors. The waterclosets, baths, and ward offices, and the drainage connected therewith, are all placed within the body of the building, some of the waterclosets against the outer walls, other in the central portions. The water supply, obtained from the public service, is received into and distributed from cisterns common to the waterclosets and to ordinary domestic uses.

Examination of structural arrangements in relation to unhealthiness of wards.

This brief general description of the Infirmary includes the essential particulars as to its structural arrangements, which appear to me necessary to be considered in attempting to elucidate the subject of the present report; and, first, of the general plan of the building.

(*a*) General plan.

The wards communicating freely with the corridors, and the corridors and different floors with each other, fouling of the internal atmosphere, whether arising from particular classes of cases in a given ward, or from local defects of drainage, if such exist, is liable to become widely diffused in the building. In proportion as the ventilation of the wards into the corridors is efficient the chances of a wide distribution of the fouled air is increased. The set of the current of air in the wards appears to be very commonly into the corridors, and thus the ward-air is drifted hither and thither in the building, retaining within the confined and imperfectly lighted spaces for an indeterminate period such powers of mischief as it may possess, and depositing on the walls dust containing effete matters. At the time of my first inspection of the Infirmary, the two small wards, "Phillips" and "Ferrier," reserved for the purpose, on the first floor, were full of erysipelas cases, and egregiously overcrowded for this class of case. The "Ferrier" ward contained *five* cases, each bed having of ward space 70 superficial and 983 cubic feet; the "Phillips" ward contained *four* cases, each having of ward space 73 superficial and 1,013 cubic feet. The standard provision of ward space for cases of this class is 144 superficial and 2,000 cubic feet. A free current of air was passing from both wards into the corridor, and, mingling with the currents there, was being swept to other parts of the building. It was hardly conceivable that the infected air, notwithstanding its dilution with the fresher air in the corridor, could be distributed harmlessly elsewhere in the building. For the dilution and the chemical effects following thereupon, it is to be inferred from experience in like cases, is neither so complete nor so rapid within a confined, and, in this instance, imperfectly lighted space, as when a current of air passes at once into the outer atmosphere.

Table III.—Wards and their Dimensions.

S. Surgical. M. Medical. E. Erysipelas.

Name of Ward.	Dimensions.	Cubic Capacity.	No. of Beds.	Cubic Space per Bed.	Floor Space per Bed.	Remarks.
First Floor.	ft. in. ft. in. ft. in.			Cubic ft.	Super. ft.	
Jenny Lind - S.	88 0×20 0×13 10	24,346	18	1,352	97	
Alexandra - S.	48 5×20 0×13 10	13,395	10	1,339	96	
Alice - - S.	53 8×20 0×13 10	14,732	11	1,473	96	Accident Ward (Male).
Byrom - - S.	20 4×20 0×13 10	5,625	4	1,406	101	
Hall - - S.	23 4×20 0×13 10	6,455	5	1,290	93	
Louise - - S.	18 2×18 0×13 10	4,921	4	1,230	81	
Treasurer - S.	74 0×18 0×14 0	18,426	14	1,316	85	Accident Ward (Male.)
Derby - - S.	32 8×18 0×14 0	8,134	7	1,162	84	
Gibson - - M.	26 10×18 0×14 0	6,681	6	1,113	80	
Phillips - - E.	15 10×18 6×14 0	4,052	4	1,013	73	
Ferrier - - E.	19 9×18 0×13 10	4,917	5	983	70	
Bridgewater - M.	24 8×19 9×13 10	6,682	6	1,118	80	Nurses Dormitory and Sick Ward.
„ - M.	30 0×19 9×13 10	8,127	8	1,016	73	
Yates - - M.	57 4×19 9×13 10	15,664	12	1,305	94	
Massey - - M.	74 0×19 7×13 10	20,046	16	1,252	90	
Second Floor.						
Humphrey Nichols S.	88 0×20 0×17 9	26,840	18	1,491	97	
Dauntesey Hulme S.	48 5×20 0×17 9	14,767	10	1,476	96	
Special Ward -	12 0×19 7×17 9	—	2	—	—	Attached to Operating Room.
Dalton - - S.	23 6×20 0×17 9	7,167	4	1,766	117	Eye Ward.
Pee - - S.	18 9×19 7×17 9	5,999	4	1,499	91	
White - - S.	19 7×18 2×17 9	5,692	4	1,423	91	
President - S.	74 0×18 0×18 7	21,312	14	1,522	95	Accident Ward (Male).
Hatton - - S.	32 9×18 1×18 7	8,158	7	1,165	86	
Mosley - - S.	60 0×18 1×18 7	17,360	12	1,446	90	
Albert - S.	30 4×18 6	8,978	5	1,796	112	
„ - S.	17 0×18 6×12 0	4,736	2	2,368	157	
Job Hindley - S.	15 10×18 6	4,686	4	1,171	73	
Dorcas - - M.	11 0×19 7×18 3	2,585	2	1,292	102	
Queen - - M.	74 0×19 9×18 3	23,627	16	1,476	92	
Brackenbury - M.	55 4×19 7×18 3	17,517	13	1,347	84	
Barnes - - M.	57 4×19 9×18 3	18,306	12	1,525	93	

(b) Position of waterclosets, baths, and ward offices.

Again, the waterclosets, the baths, and the ward offices ventilate, in effect, into the corridors, the set of the air from the windows of those against the outer wall being generally inwards, while those within the central portions of the building have no other outlet for such air as passes from them. In the event of any diffusion of sewer-air through the water of the traps (a necessity where the drain is foul and unventilated), or of a direct inflow of sewer-air through an imperfectly sealed trap (a commoner event than is usually supposed where, as in the case of the waterclosets, baths, and sinks of the Infirmary, no provision is made to prevent the traps becoming unsealed), this air passes into the corridors, and is distributed within the building. Few facts are, perhaps, more clearly established in medicine than the mischievous influence of an atmosphere pervaded with sewer-air in surgical wards. Now the waterclosets, the baths, the ward offices, and the drains of the Infirmary generally being placed within the building, several of the closets without even direct communication wtth the outer air, sewer-air escaping from them must necessarily pass into the corridors and wards. The inquiry has shown that there are peculiar liabilities to such an escape of sewer-air in the arrangements for the Infirmary under consideration. In the first place, no adequate provision is made for the ventilation of the soil-pipes of the waterclosets; indeed, practically, there is no provision, for the open pipes of small calibre which have been inserted into the upper ends of the soil-pipes are wholly ineffectual for the purpose of ventilation. The soil-pipes serve also as rain-pipes, and at the upper part are trapped, the air-pipe previously mentioned being inserted beneath the trap. Soil-pipes in this condition are constantly charged with sewer-air, which is apt to make its way into the closet by diffusion through the water of the trap, or through a trap which may have become unsealed, or by the trap being forced, when the soil-pipe acts also as a water-pipe, during the passage of a rush of rain down the pipe, dislodging the contained air violently in its passage. An influx of sewer-air into the basement of the north wing, brought about in this manner, occurred during the inquiry, and will be described presently.

(c) Drains and drainage.

But, next, the drains into which the soil-pipes and other drainage pipes open in the basement of the building are of a construction which, I hope, it is rare to find in the present day in an English hospital, even of the age of the Manchester Infirmary. Indeed, no definite knowledge existed of the drainage of the building when this inquiry began, and such *traditional* knowledge as was at first available proved to be largely erroneous. No plan of the drains appears to have existed since the completion of the building, and in the progress of time the knowledge of their position, dimensions, and construction has become vague. So much was this the case that the existence of an important drain in the basement of the north wing had been forgotten; and the position of the outlet of the main drain was unknown until re-discovered in the course of this inquiry by a search party of the sewers' staff of the Town Council, and then not without recourse to excavations along the presumed course of the drain. My inquiry into the state of the drains was carried only so far as to show the necessity of a complete exploration of the drainage by a competent engineer.* Drains were found for me, and opened at several points in the basement and areas of the building, and with the

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* A preliminary exploration is now being made by Mr. Rogers Field, C.E., who will report in detail on the state of the drainage. The complete exploration contemplated in the text will, it is to be feared, be scarcely practicable while the building is occupied by patients. *See* Note II. [*See* also extracts from Mr. Field's report of the results of his exploration which I now give, Note III. J.N.R.]

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following results. The smaller drains proved to be rectangular and constructed of brick. In the basement of the south wing one of these drains (12 ins. × 12 ins.) was found filled to within 3 ins. of the top with horribly offensive stuff. In the basement of the central block another drain (? a continuation of the former) of the same dimensions was found, containing a deposit, 3½ ins. in depth, of equally offensive matter. Another drain of like dimensions, and having a considerable dip, coming from the north wing, &c., to the area behind the Infirmary, showed a slight deposit upon the bottom, notwithstanding the steepness of its fall. Another, lying superficially in the north-east angle of this area, with still steeper fall, was clear, but presented the remarkable spectacle of an iron water-pipe (said to be disused) passing tranversely through it, and a lead pipe (subsequently shown to be a water-pipe in use) lying within it. Rat runs were observed in several parts of the basement, a recent one being pointed out in one of the still-rooms of the north basement. The main drain was examined through "eyes," one fixed in the north-east angle of the back area for the purpose, another in the north area. Through the former "eye" the main drain (3 ft. 6 ins. by 2 ft. 9 ins.) was seen, a thick layer of mud resting on the rounded bottom, and on the sides of the shaft of the "eye" a trickling of water indicated leakage from some neighbouring superficial drain or water-pipe. Through the "eye" in the north area a thick deposit was seen damming the current in the drain. The deposit proved to be formed chiefly of a large collection of filth and of fragments apparently of floor cloths, bandages, and other stuffs collected around the partially erect handle of a mattock, having the initials of the Municipal Waterworks upon it, and of which no account could be given, but which had evidently lain where it was found a long time. The inspection proved that a considerable period had elapsed since the drains had been last examined, how long could not be determined. That the condition of the drains here described must, as long as it had existed, have exercised an evil and growingly mischievous influence upon the atmosphere in the hospital, partly through the permeability of the bricks and flagstones which entered into their construction permitting the passage of sewer-air, but more through the manner in which they were connected with the different parts of the building by the various waterclosets, sinks, and baths, and especially from the direct openings into them by means of the rat runs, is inevitable. This state of the drains, a state which it is reasonable to conclude has been the ordinary state of the hospital drainage since the completion of the Infirmary, must unquestionably have played an important part in the perpetuation of the unwholesomeness of the building to the patients treated in it. It is a state not the less dangerous, because in the ordinary condition of free ventilation of the wards and corridors the diffusion of sewer-air in them may not have been obvious to the senses. But clear indications of the lurking danger were not wanting in occasional irruptions of fœtid sewer-air from some of the waterclosets. During my inquiry an irruption of this kind took place from the waterclosets in the basement of the south wing, following upon a heavy thunder shower, which had doubtless suddenly filled up the small remaining capacity of the drain there, forcing out the stinking sewer-air through the waterclosets. The sewer-air had poured into the basement, whence it was diffused through the staircase and hoist-shaft to other parts of the building. It was unpleasant to know that the rooms on either side of the basement-corridor, underneath which, at a slight depth, lay the foul drain which has been described, were occupied as bed rooms by nurses and servants. So-called "hospital sore throat" is stated to be common among the nurses, no new nurse ever escaping this affection. It would have been inte-

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resting to have ascertained whether sore throat was more prevalent or more severe among the nurses who slept in the basement than among those who slept in other parts of the building. But, unfortunately, no separate records are kept of sickness among the nurses, such cases of sickness among them as are sent into the wards, and which are entered in the general registers, being alone noted. The instructive light which might have been thrown upon the health state of the Infirmary from a systematic record of the ailments of this important class of its occupants is not forthcoming.

As in the basement of the south wing, so in the basement of the north wing, a rectangular brick drain runs beneath the corridor, which in addition to other matters receives the drainage of the post-mortem room. The existence of this drain was discovered after I had terminated my inquiry upon the spot. When opened at two points, some, but not much, deposit was found there. This drain is probably freely opened to the basement by rat runs and other fissures. The vapour of burning sulphur, ignited experimentally in the main drain, at the bottom of the "eye" in the north area, poured freely into the basement where the first-mentioned drain is now known to be.*

If the recommendation made by the medical staff in 1861, and reiterated in 1863, that the waterclosets should be removed from the interior of the Infirmary, and built out from it so as to admit of their being separated from the main building by cross-ventilation, had been carried into effect, *it is* reasonable to suppose that much of the subsequent unwholesomeness in the wards would have been escaped.

(*d*) Water supply.

I may recur here to the fact already mentioned of the water-cisterns being common for the supply of the waterclosets and for domestic uses generally. The impropriety of this arrangement should be obvious, especially after what has been said of the drainage of the Infirmary. In one instance at least a soil-pipe is carried above the roof through one of the cisterns.

(*e*) Dispensary.

The use of the ground floor of the north wing for the Dispensary appears to me very objectionable in a building planned as the Infirmary. Although the Dispensary is cut off from the Infirmary corridor by swing doors, the separation, from the constant passing of persons backwards and forwards, is more apparent than real, and the crowds which collect on several days in the week in the out-patients waiting-rooms can hardly fail to be detrimental to the purity of the atmosphere in the Infirmary, particularly on the surgical side.

(*f*) Ward arrangement.

Taking the most ordinarily received standard of ward space per bed, a standard let it always be remembered less important in itself, than as indicating the conditions of ward space best adapted for securing (in the general state of occupation of wards) the most thorough ventilation, the capacity of the greater number of the wards would appear to leave little to desire. The space standard here referred to is 90 superficial feet, 1,200 cubic feet, and 7 feet 6 inches wall space. Several of the smaller wards are obviously, according to this standard, overcrowded with beds (*e.g.*, "Derby," "Gibson," "Ferrier," "Phillips," "Louise," "Hatton," and "Job Hindley" — "Gibson" being a medical ward, "Ferrier" and "Phillips" the wards for erysipelas, the remainder surgical wards), but the other wards fairly attain and in some respects exceed it. (*See* Table III.) But this space standard, be it observed, has been arrived at with reference to the whole conditions of ventilation that should exist in a ward. It presupposes certain standard facilities for the interchange of air in the ward to which the space standard has to be applied. If these facilities are wanting, so that the space tenanted by a given number of patients cannot be kept up to the required degree of purity, the number of patients must be reduced in proportion as the facilities of interchange of air are lessened, in other words the space for each patient must be increased. Now the space standard has presupposed a ward of at least 24 feet in breadth, lighted and admitting of being placed in direct communication with the outer air on both sides by windows. It is quite inapplicable. and in respect to surgical cases altogether insufficient, for wards opening on a central corridor, and lighted and admitting of direct communication with the outer air on one side only. Here a much larger superficial and cubic space per bed is required, although no increase of ward space in such wards will give the advantages arising from the better construction to which the standard is adapted. For any great increase in the breadth of wards arranged as those in the Manchester Infirmary would largely increase the difficulties of cross-ventilation. Again, the standard presumes wards in which ordinary cases of disease or injury are to be treated, that is to say, cases which from their nature are not liable to foul the ward atmosphere to any exceptional degree. The aggregation of surgical cases, and especially of accidents, in wards set apart for them, as is the practice in the Manchester Infirmary, demands a different standard.

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* Dr. Gray of Oxford has directed my attention to the possible relation of a drain carrying, among other sewage, the liquid refuse of a post-morten room, to prevalence of erysipelas in a surgical ward. Recent physiological experiments of Dr. Burdon Sanderson and others on certain special septic properties of putrefying animal matters give great interest to this suggestion

But even apart from these general considerations the standard is singularly delusive in its application to the wards under consideration. The narrowness of the wards appears to me to counterbalance such advantages as might be obtained from an excess which exists in several wards of wall space above the standard. Thus in the two male accident wards, the "Treasurer" and the "President," with a wall space of 10 feet per bed, but 5 feet intervenes between the beds on opposite sides of the wards. If the wards were freely ventilated and lighted from both sides, the narrowness of this intervening space might perhaps signify little except as a matter of deficient room for ward service. But in wards lighted and ventilated from one side only, the narrowness suggests a very undesirable commingling of the bed atmospheres on the opposite sides of the wards. Again, in the calculations of the cubic capacity of the wards there is included for those on the upper floor the space contained within the arched ceilings, which rise in the centre to a height of from 8 to 10 feet above the upper level of the windows. Although certain openings exist in these ceilings leading into shafts passing above the roofs, and other openings through the walls of the wards facing the windows, and above their level, communicate with the corridors, the air within the arched space must change sluggishly, and practically should be held of little account in estimating the available capacity of the wards.

On the second floor the larger number of cases of traumatic infections during their recent prevalence have occurred. Here the wards have, hygienically considered, smaller capacity relatively to the beds in them, they have much less window space, and generally less efficient ventilation, than the wards on the floor below, while their atmosphere is liable to greater fouling from impurities, sewer or other, diffused in the general atmosphere of the building (the upper floor in this respect acting in some sort as a receiver towards the lower floors). Of 78 cases of erysipelas, pyæmia, and septicæmia, of which the distribution in the various wards is known, 50 occurred in the wards on the second floor, and

28 in the wards on the first floor (*see* Table IV.).* The ward in which the greater number of cases occurred was the "President," the male accident ward, situated on the second floor, and which, in addition to other structural defects, is partly situated beneath the east portico. The portion of the ward darkened by the portico (then a separate room) was condemned for ward purposes by the medical staff in 1861.†

(g) Position of dead-house and post-mortem room.

The position of the dead-house, and practically also of the post-mortem and pathologist's rooms, within the body of the building, especially on the surgical side—the drainage of the two latter rooms and doubtless of the dead-house also, communicating with the drains of the north wing—appears to me highly objectionable. The records of the hospital, as already related, furnish an instance of one of the ways in which a dead-house, situated beneath or contiguous to surgical wards, may become mischievous to the patients therein. If the drainage of the dead-house and of the post-mortem and pathologist's rooms were cut off from the house drains, it would be difficult even then to make sure that all the sources of the subtle mischiefs which may arise during the temporary housing of the dead, and the examination of bodies within the building, have been securely guarded against.

(h) Position of laundry and bandage house.

Scarcely less objectionable in my opinion is the position of the laundry, particularly with reference to the surgical wards. It is true that here the most obvious objection attaching to the contiguity of a laundry to surgical wards, namely, the defilement of the atmosphere by impure matters carried into it in suspension by the steam given off during ordinary processes of washing dirty linen, is in great measure removed by the use of steam, in close iron vessels, for cleansing. But the lessening of the danger in one direction, gives rise in this case to an even greater in another. The waste steam of the laundry is passed into the drains, heating them, and thus favouring decomposition of the retained matters there, and the passage of the products of decomposition into the interior of the building. Moreover, while the drains are made the outlet of the waste steam their proper ventilation will be impracticable.

A special wash-house exists for dirty bandages in the central area, close to the north wing. Here the washing is also effected by steam, the waste steam being passed into the main drain at a point where it may most mischievously affect the drains of the building.

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* Table IV.—Number of Cases of Erysipelas, Pyæmia, and Septicæmia, occurring in the several Wards 1875, and to 12th June 1876.

First Floor.	
Jenny Lind	9 cases.
Treasurer	8 "
Alice	6 "
Alexandra	3 "
Byrom	1 "
Louise	1 "
Hall	0 "
Derby	0 "
Gibson	0 "
Bridgewater	0 "
Yates	0 "
Massey	0 "
	28

Second Floor.	
President	13 cases.
Job Hindley	7 "
Humphrey Nichols	8 "
Dauntesy Hulme	6 "
Mosley	5 "
Albert	2 "
White	2 "
Peel	1 "
Brackenbury	4 "
Barnes	1 "
Queen	1 "
Dorcas	0 "
Dalton (Eye)	0 "
	50

† On the 14th January of the present year Mr. Thomas Harrison, F.C.S., at the instance of Mr. Messenger Bradley, made an examination of the state of the air of the President ward, with respect to purity, as shown by the proportion of carbonic acid contained in it. The result obtained is stated as follows :—

Estimate of the quantity of Carbonic Acid in 10,000 *volumes of air.*

President ward 18. Corridor adjoining 4. Manchester air (average) 4.

See Clinical Lecture on Septicæmia.—*Lancet*, vol. I., p. 769.

EXAMINATION OF ADMINISTRATIVE ARRANGEMENTS IN RELATION TO UNHEALTHINESS OF WARDS.

(1) Surgical and other overcrowding.

III. The structural arrangements which have been described, appear to me fully to account for the unsuccess of the various measures which have been taken from time to time to prevent the frequent recurrence of traumatic infections in the surgical wards. Other co-operating conditions have, however, contributed to the extension and development of the mischiefs arising therefrom, and these conditions, which relate to matters of administration, I now propose to consider.

Although the statement at first may seem paradoxical, it is highly probable that the addition of the Barnes Convalescent Hospital to the Charity has exercised an unfortunate influence in promoting the later prevalence of traumatic infections in the Infirmary. How this has come about will be understood from what follows:—

Notwithstanding that the addition of the convalescent and "fever" hospitals has now practically doubled the available bed accommodation of the Charity, this is still insufficient to meet the demands upon it. According to a record kept by the house physician, not less than 108 cases of urgent sickness sent to the hospital, recommended by subscribers, and proper for admission as in-patients, were, from the 25th October 1875 to the 26th June 1876, rejected from want of accommodation. Some of these cases would be received afterwards as beds became vacant. To these cases have to be added a considerable number of urgent cases brought to the hospital without a recommendation, and of which number no record has been kept. Numerous undesirable but unrecorded rejections occurred also on the surgical side. The absolute rejections of cases for want of room, together with the number of patients treated in the Infirmary and from the Dispensary, during the past 20 years, as shown in the Infirmary records, are given in the subjoined table (V.)*

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* TABLE V.—A.—RETURN of NUMBER of ADMISSIONS to INFIRMARY, year by year, for the past 20 years; showing number of Cases rejected from want of room, and number of Cases admitted to Convalescent Hospital.

Year ending June 24th.	In Patients.				"Fever" and Small-pox Patients.	Rejected from want of room.	Convalescent Hospital Patients.
	Medical.	Surgical.	Of which Surgical cases Casualties.	Total.			
1856	Not distinguished.		957	2,054	—	54	—
1857	,,	,,	808	1,954	279	76	—
1858	,,	,,	673	1,689	282	75	—
1859	,,	,,	715	1,791	220	135	—
1860	,,	,,	896	2,063	120	162	—
1861	,,	,,	993	2,001	79	175	—
1862	439	1,220	709	1,659	182	139	—
1863	429	1,287	674	1,716	189	134	—
1864	435	1,295	758	1,730	204	98	—
1865	591	1,543	840	2,134	268	82	—
1866	698	1,957	1,157	2,650	309	118	—
1867	612	1,838	1,144	2,450	199	56	Opened Nov. 1867.
1868	639	1,720	1,005	2,359	239	51	101
1869	520	1,713	1,006	2,238	438	64	326
1870	651	1,712	1,008	2,363	317	36	376
1871	897	1,630	958	2,527	411†	41	443
1872	874	1,836	1,072	2,710	700	46	415
1873	920	1,943	1,050	2,863	306	45	388
1874	890	1,911	1,047	2,801	126	43	431
1875	980	1,912	1,085	2,892	253	35	407

† The Monsall "Fever" Hospital opened 1871, and since the opening "fever" and small-pox patients have been carried there.

The accommodation of the Infirmary appears, indeed, at all times to have lagged behind such charitable needs, both medical and surgical, of Manchester and the surrounding district as it was intended to supply; and to the inadequacy of the building for the number, and in certain important respects the kind, of sick continually seeking treatment in it, as much perhaps as to structural faults, is due its abiding unwholesomeness. For while, on the one hand, experience had shown that a larger ward space per bed than has yet been secured was required, this larger space could only be obtained by a sacrifice of beds such as became practically impossible in face of the increasing and already largely unsatisfied demands upon the Infirmary; and, on the other hand, the impracticability of satisfying all demands, compelled a selection of those of a more serious nature, and the consequent aggregation in the surgical wards of cases of injury requiring even larger ward space than had at any *time* been contemplated, if a mischievous state of the ward atmosphere was to be certainly avoided. No part of ward management, even in the most capacious and best-arranged wards, calls for more constant and thoughtful care than the distribution of certain kinds of surgical cases. "The difficulty of providing adequate ventilation for a given "surgical case varies with the nature of the case—the generation of "foul products being in some cases no more than in health, while in "other cases it is enormously large; and a ward, which could be "adequately ventilated if it contained a fair admixture of these two "classes of cases, may have an entirely unmanageable intensity of "traumatic atmosphere if only the latter class of cases be received "*into it*. Such a ward is, in every practical sense of the word, over-"crowded, and the consequences of surgical overcrowding [namely, an "increased liability to the rise and spread of traumatic infections] will "arise in it."* Now, while the constant pressure upon the accommodation of the hospital had for one of its results to bring about over-

Table V.—B.—Return of Number of Patients under Treatment from Dispensary, year by year, for the past 20 years.

Year ending June 24th.	Out-Patients.			Home-Patients.		
	Medical.	Surgical.	Total.	Medical.	Surgical.	Total.
1856	Not distinguished.		20,315	—	—	1,543
1857	„	„	19,407	—	—	3,108
1858	„	„	17,141	—	—	2,760
1859	„	„	19,242	—	—	3,116
1860	„	„	19,891	—	—	3,483
1861	„	„	20,820	—	—	3,203
1862	„	„	23,199	—	—	3,614
1863	„	„	25,253	—	—	3,240
1864	„	„	23,914	—	—	3,233
1865	„	„	21,518	—	—	2,929
1866	„	„	22,793	—	—	3,095
1867	„	„	21,966	—	—	2,775
1868	„	„	20,802	—	—	2,687
1869	„	„	18,959	—	—	2,857
1870	9,385	10,458	19,843	353	2,276	3,251
1871	8,863	10,129	18,992	362	2,154	2,717
1872	7,948	14,286	22,234	394	2,180	2,574
1873	6,608	12,493	19,096	350	1,343	1,693
1874	5,457	11,893	17,350	409	1,645	2,054
1875	5,208	11,657	16,865	326	1,407	1,733

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* Simon.—*Sixth Annual Report of the Medical Officer of the Privy Council*, p. 70.

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crowding of the kind here described, the opening of the convalescent hospital appears markedly to have confirmed this particular result. For convalescent surgical cases, and even other cases not convalescent but admitting of removal,* were drafted off to the convalescent hospital to make room for graver cases of disease and injury. During the recent prevalence of erysipelas there would appear to have been a considerable degree of surgical overcrowding of the wards from time to time.† But while the convalescent hospital, from all I can gather, would in this manner appear to have exercised a mischievous effect upon the wholesomeness of the wards of the Infirmary, it must be borne in mind that this result does not detract from the exceeding value of the hospital as an addition to the charity, although it furnishes another and very manifest illustration of the inadequacy of the Infirmary for the surgical work which is done in it.

(b) The control of infection.

Of other administrative conditions which have been referred to as contributing to the unwholesome state of the wards, the next in importance relates to the control of infection. The traumatic infections are peculiarly subtle and readily portable, especially the infection of erysipelas. Cardinal conditions for the control of these infections in hospital wards are the immediate isolation of the cases as they occur, and the strict avoidance of all practices in the case of patients and ward management which may disseminate infection: such, for example, as the use of sponges, the neglect of disinfecting hands and instruments in passing from case to case, the retention of disused dressings in the wards, and the want of proper receptacles for them, together with the absence of fitting regulations for their removal and destruction, the use by the nurses of dresses of porous, unwashable materials, liable if soiled by discharges to retain infection, defective means for cleansing

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* Two wards of the convalescent hospital were occupied by cases of this kind at the time of the inquiry.

† In examining the surgical register my attention was arrested, having regard to the imperfect registration, by the number of cases of "gangrene," following upon severe injuries, registered in some years. Thus in 1872 there were seven cases, in 1873 four, and in 1874 eight. Two cases only of secondary gangrene were registered in 1875, and to the 12th June in 1876. The register in respect to the number of cases in which gangrene may have supervened is not more accurate than in respect to the number in which erysipelas, pyæmia, or septicæmia may have supervened. The following observations of Simon touching gangrenous wounds in a ward may, perhaps, be usefully quoted here :—"Any wound in the unhealthy state "which is technically called 'foul' is in fact a surface of decaying animal matter; "that which surgeons call a 'slough,' or 'mortified' part, is a dead bit of the animal "body undergoing just such putrefactive changes as it might undergo in the dissecting room; and accordingly if cadaveric decomposition can easily furnish the "contagium of erysipelas, every surgical ward of an active hospital must (in "respect of the natural processes of disease going on in it) be a likely birthplace of "that contagium. Thus, for instance, if a patient has been admitted with a contused wound of such severity as involves local mortification ['gangrene,' in the "sense of the word used in the surgical register], that mortification would include "in itself an essential liability to the formation of erysipelas contagium."—*Sixth Report*, p. 60.

. . . . "An attack of any of the traumatic infections has generally the same "meaning as an attack of traumatic erysipelas. It is true that any member of the "whole series—erysipelas, pyæmia, softening of clot, gangrene, phagedæna—may, "within a large surgical experience, occur to some considerable extent from causes "which are purely personal. And (especially where such is the origin) one of "them may occur without the others. But except where personal conditions "exclusively decide the occurrence of these lamentable infections (and clearly this "is only to a limited extent) they tend to prevail conjointly or in succession. That "they differ from one another in the intimate nature of their respective chemical "processes is possible or even probable; but that they have in common an intimate "affinity with ordinary putrefactive processes seems to be the leading fact in their "pathology."—*Sixth Report*, p. 62.

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and disinfecting bedding and bed-linen, and fouled linen generally, &c. The avoidance of the last-named practices is a matter of ordinary hospital ward management; for the secret of success in preventing the development of traumatic infections in wards is to act systematically as if every case of wound or injury might become a source of infection to other cases: and the measures referred to aim solely in securing the greatest attainable cleanliness in all things affecting the injured part and the surroundings of the patient.* One only of these conditions obviously failed at the time of my inquiry, so far as my observation extended, in the ward management of the Infirmary, namely, the want of proper impervious receptacles for dressings removed from the patients, and for fouled linen before removal from the ward offices. The practice, as I saw it, appeared to be to cast them in a heap upon the floor of the bath-room until they were removed.

The efficient isolation of cases of traumatic infections as soon as recognised, it must be obvious, will afford the greatest security against the spread of the several diseases. If erysipelas occur in a hospital it is little likely that the common sources of infection will be closed unless the cases are strictly isolated. Indeed, the history of the recent prevalence in the Manchester Infirmary furnishes an instructive illustration of the insufficiency of certain special surgical means, directed to prevent the spread and development of this disease, to effect these objects, while patients suffering from the malady are still present in the building. Three of the surgeons, at the time of erysipelas becoming epidemic in the Infirmary in 1875, were following methods, antiseptic so-called, in the treatment of their cases, which aimed at the prevention of traumatic infections. In especial, Mr. Lund, practised Mr. Lister's antiseptic method, himself superintending every detail, and varying only in one unessential matter, as he thinks, in the preparation of the covering material, the "antiseptic gauze." None of these methods obviated wholly the occurrence of erysipelas in the patients subjected to them, but the patients under Mr. Lund's care probably suffered less in proportion from the infection than the patients under the care of his colleagues. What part may have been played by infection or by the insanitary condition of the wards in the development of erysipelas under these circumstances it is impossible now to say; but the probability of the disease in these instances originating in infection cannot be excluded, as will presently be seen.

After the opening of the Monsall Hospital in 1871, cases of erysipelas sent to the Infirmary were not admitted there, but were at once conveyed to the former hospital, and to this important extent the chances of introduction of the infection into the wards were diminished. This rule, has, perhaps, not been so rigidly acted upon as was needful.

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* "The rules of hospital hygiene are, in principle, simple enough. That which " makes the healthiest house makes likewise the healthiest hospital—the same " fastidious and universal cleanliness, the same never-ceasing vigilance against the " thousand forms in which dirt may disguise itself in air and soil and water, in walls " and floors and ceilings, in dress and bedding and furniture, in pots and pans and " pails, in sinks and drains and dustbins. It is but the same principle of arrange- " ment, but with immeasurably greater vigilance and skill: for the establishment " which has to be kept in such exquisite perfection of cleanliness is an establishment " which never rests from fouling itself; nor are there any products of its foulness, " not even the least odours of such products, which ought not to be regarded as " poisons. Above all, this applies to the fouling of the air within hospital wards by " exhalations from the persons of the sick. In such exhalations are embodied the " most terrible poisons of disease—the spreading flame, as it were, of some infec- " tions, and the explosive fuel of others; and any air in which they are let accumu- " late soon becomes a very atmosphere of death."—Simon, *Sixth Report, p.* 52.

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During the inquiry, a patient suffering from diseased bones of the foot, with commencing erysipelatous inflammation of the superficial tissues above the seat of disease, was admitted into the Infirmary and placed in a bed next to a recent case of thigh amputation. A case of clot-softening, of erysipelatous origin, in the arteries of a stump (thigh) of a fortnight's date, and followed by secondary hæmorrhage, had occurred in the ward a few hours before the admission of the patient referred to. Cases which were developed in the wards were also sent as quickly as practicable to Monsall. But many of these latter cases did not admit of immediate removal; in not a few, moreover, removal was impossible, 22 patients having died in the Infirmary during 1875, and to the 12th June 1876, either from erysipelas supervening upon their injuries, or with erysipelas complicating them. These cases were taken from the surgical wards and placed in two wards set apart for the purpose on the first floor of the building, the "Phillips" and the "Ferrier." Here they remained an undeterminate period under the charge of the house physician, and of nurses whose duties were confined to the two wards. I have already described the relations of these wards to the wards generally. It is simply necessary to add that the nurses were in ordinary communication with their fellow-nurses; and had free access to the remainder of the building, to show that the separation of the patients under these circumstances afforded but slight, if any, security against the dissemination of the infection. Moreover, the house physician having charge of the erysipelas wards had also charge of the medical wards, including the obstetric physician's ward. There can be no doubt that the fatal ending of the four instances of tapping for ascites in the last-named ward, mentioned in a previous part of this report, was due to the introduction of the infection of erysipelas into the ward from the erysipelas ward. Isolation such as is needed to limit the spread of traumatic infections can only be obtained with certainty in a separate building, with separate nursing staff. The Monsall Hospital, on account of its distance from the Infirmary, does not, unfortunately, meet all the exigencies of the case. To provide for the exigency of a patient being attaked by a traumatic infection who is not in a state to be moved to a distance, detached wards adjoining the Infirmary are imperatively needed, if the safety of other patients from the infection is to be secured.

It is not practicable to indicate the respective parts which the several conditions capable of promoting unwholesomeness of the wards, described in the two preceding sections, have played in determining the prevalence of erysipelas and other allied infections in them. The imperfect registration of the several cases prevents this being done, and I have no choice but to substitute a general account for those precise details which an accurate and sufficient registration would have enabled me to give.

SITE OF INFIRMARY.

IV. The questions hitherto considered have referred to the structural arrangements and to the administration of the Infirmary. The question of site remains. Until it was possible to eliminate the effects upon the patients received into the wards of the different unfavourable conditions which have been described, it would be impracticable to estimate the influence exercised by the site of the building. This question must then be judged on general hygienic principles. Of the *soil* upon which the Infirmary stands very little precise appears to be known. It is stated to be clay and "made ground," the original ground have doubtless been much disturbed in the process of building the Infirmary and forming the area about it. Such objections indeed as attach to a soil, on account of its being retentive of moisture, for the site of a hospital can hardly hold

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here, it may be inferred, under these conditions and after, say, half a century's deep subsoil drainage, when doubtless they have become practically inappreciable. Such evils of site as may exist in relation to soil will be those (as yet to be ascertained by actual inspection) which may have been created by particular foulings of the soil from sewage leaking and soaking through the walls of imperfect drains. The atmosphere in which the Infirmary stands, overladen with the smoke and dust of a vast manufacturing city, and the great noisiness of the streets surrounding the area within which the building lies, are both objectionable; but the uncleanliness of the outer atmosphere is not of that sort, and the disquiet from the noise of the street is not, as seemed to me, so considerable as to furnish any serious reason for a change of site, if such change involved the sacrifice of the condition which is of first moment in a great surgical hospital, namely, readiness of access for the injured.

SUMMARY AND ANSWERS TO QUESTIONS OF SITE COMMITTEE.

V. I now proceed to answer categorically the questions put by the Site Committee in their several resolutions of the 13th and 23rd March 1876, and to summarise in this manner the conclusions I have arrived at in the preceding report. The recommendations arising out of these conclusions, and various matters related therewith, will form the subject of the concluding section.

1. "*As to the salubrity of site in reference to the Infirmary requirements.*"—No data exist which would permit a judgment to be formed of the influence of the site upon the progress of patients treated in the Infirmary. The question must be dealt with on general hygienic principles, and from these I infer that, while the site is open to objection in several respects, the disadvantages attaching to it are not of a nature to outweigh the more serious consideration which attaches to readiness of access to a surgical hospital for the population it is intended to serve.

2. "*The sanitary condition of the hospital, including drainage.*"—The sanitary condition of the hospital is bad, whether estimated from the prevalence of erysipelas and of other traumatic infections within the wards, or from its close packing from basement (cellars?) to garret, with nurses, patients, and servants and the staff generally, or from the generally too crowded state of the wards, and especially from the surgical overcrowding, or from the utterly faulty plan and construction, and present excessively foul state of its drainage.

3. "*The suitability and adaptability as regards construction and accommodation.*"—Bad as is the existing sanitary condition of the Infirmary, and consequent unsuitability for hospital purposes, the building ought not to be condemned unconditionally. Its adaptability for hospital purposes will, however, in my opinion, depend upon changes being made which in their nature will so seriously diminish the usefulness of the present building, without affording such surety of success as is desirable, that it will become a question, apart from all consideration of the costs these changes would involve, whether they should be entertained as an alternative to the erection of a new hospital or hospitals. The changes referred to are described in the following section.

RECOMMENDATIONS.

VI. In the recommendations which here follow I propose to answer the questions of the Site Committee as to (A.) the "suitability (of the Infirmary) to meet modern requirements in regard to hospital accommodation," and (B) "as to any alterations which may be thought necessary."

(A.) The first of these questions, as I understand it, regarding the

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IV. The questions hitherto considered have referred to the structural arrangements and to the administration of the Infirmary. The question of site remains. Until it was possible to eliminate the effects upon the patients received into the wards of the different unfavourable conditions which have been described, it would be impracticable to estimate the influence exercised by the site of the building. This question must then be judged on general hygienic principles. Of the *soil* upon which the Infirmary stands very little precise appears to be known. It is stated to be clay and "made ground," the original ground have doubtless been much disturbed in the process of building the Infirmary and forming the area about it. Such objections indeed as attach to a soil, on account of its being retentive of moisture, for the site of a hospital can hardly hold here, it may be inferred, under these conditions and after, say, half a century's deep subsoil drainage, when doubtless they have become practically inappreciable. Such evils of site as may exist in relation to soil will be those (as yet to be ascertained by actual inspection) which may have been created by particular foulings of the soil from sewage leaking and soaking through the walls of imperfect drains. The atmosphere in which the Infirmary stands, overladen with the smoke and dust of a vast manufacturing city, and the great noisiness of the streets surrounding the area within which the building lies, are both objectionable; but the uncleanliness of the outer atmosphere is not of that sort, and the disquiet from the noise of the street is not, as seemed to me, so considerable as to furnish any serious reason for a change of site, if such change involved the sacrifice of the condition which is of first moment in a great surgical hospital, namely, readiness of access for the injured.

SUMMARY AND ANSWERS TO QUESTIONS OF SITE COMMITTEE.

V. I now proceed to answer categorically the questions put by the Site Committee in their several resolutions of the 13th and 23rd March 1876, and to summarise in this manner the conclusions I have arrived at in the preceding report. The recommendations arising out of these conclusions, and various matters related therewith, will form the subject of the concluding section.

1. "*As to the salubrity of site in reference to the Infirmary requirements.*"—No data exist which would permit a judgment to be formed of the influence of the site upon the progress of patients treated in the Infirmary. The question must be dealt with on general hygienic principles, and from these I infer that, while the site is open to objection in several respects, the disadvantages attaching to it are not of a nature to outweigh the more serious consideration which attaches to readiness of access to a surgical hospital for the population it is intended to serve.

2. "*The sanitary condition of the hospital, including drainage.*"—The sanitary condition of the hospital is bad, whether estimated from the prevalence of erysipelas and of other traumatic infections within the wards, or from its close packing from basement (cellars?) to garret, with nurses, patients, and servants and the staff generally, or from the generally too crowded state of the wards, and especially from the surgical overcrowding, or from the utterly faulty plan and construction, and present excessively foul state of its drainage.

3. "*The suitability and adaptability as regards construction and accommodation.*"—Bad as is the existing sanitary condition of the Infirmary, and consequent unsuitability for hospital purposes, the building ought not to be condemned unconditionally. Its adaptability for hospital purposes will, however, in my opinion, depend upon changes being made which in their nature will so seriously diminish the usefulness of the present building, without affording such surety of success as is desirable, that it will become a question, apart from all consideration of the costs these changes would involve, whether they should be entertained as an alternative to the erection of a new hospital or hospitals. The changes referred to are described in the following section.

RECOMMENDATIONS.

VI. In the recommendations which here follow I propose to answer the questions of the Site Committee as to (A.) the "suitability (of the Infirmary) to meet modern requirements in regard to hospital accommodation," and (B) "as to any alterations which may be thought necessary."

(A.) The first of these questions, as I understand it, regarding the suitability of the Infirmary to meet hospital requirements as it is now commonly accepted that they should be, wherever it is practicable to obtain them, is readily answered. The Infirmary is not only not suitable to meet such requirements, but the changes involved in adapting it to them would, on the one hand, render necessary a sacrifice of probably at least one half of the beds, and, on the other, would, I surmise, involve practically (indeed this would be the easier course) a reconstruction of the building.

(B.) The second of the questions stated, namely, "as to any alterations which may be thought necessary," in view, as I read it, of the present building being still retained in use as a hospital, is complex. In dealing with it, as will already have been inferred from the preceding report, administrative as well as structural matters have to be considered. Treating this question quite independently of the preceding question, the recommendations relating to it, which appear to me to arise out of the inquiry, are as follows :—

1. *As to Structural Arrangements.*

(*a.*) The waterclosets, bath-rooms, and slop-sinks should be removed from within the body of the building and placed in projections to be built for the purpose, which would admit of efficient cross-ventilation of such offices and approaches thereto. The whole of the drains also should be placed exterior to the building, and, under the supervision of a competent engineer, they should be properly re-planned and reconstructed, due regard being given to their efficient ventilation and to the interposition in every instance of communication with the interior, whether by means of soil-pipes, sink-pipes, or other pipes, of sufficient ventilating breaks between them and their connexion with the main drains, and between the latter and the public sewers. Preliminary to these changes a complete exploration of and about the basement of the building would be necessary for the discovery of forgotten drains, or it may be cesspools, and for the removal of existing drains and cesspools, (if cesspools be found), making good, after their removal, all contaminated soil occasioned by leakage or soakage from them.

(*b.*) The plan of water supply requires to be rearranged, water pipes being removed from drains and their near neighbourhood, and separate cisterns for the waterclosets provided.

(*c.*) The arched ceilings of the wards on the second floor should be freely lighted by dormer windows capable of being opened, even if this alteration should involve considerable reconstruction.

(*d.*) Parts of wards on the second floor beneath the shadow of the porticoes should be disused and converted to some other purpose.

In making these recommendations I repeat substantially the recommendations of the medical staff of the Infirmary made in 1861, and again in 1863.

2. *As to the provision for Traumatic Infections.*

A detached building, with separate kitchen and offices, and accommodation for a distinct nursing staff, is essential, adjacent to the Infirmary, for the immediate reception of cases of traumatic infection developed within the wards, which do not admit of removal at the moment to Monsall. A building of two wards containing four beds each (one ward for males and one for females) would probably be amply sufficient for this requirement of the Infirmary. A building of this class, constructed on the principles applicable to infectious-disease hospitals, should be regarded as an essential part of every surgical hospital.

3. *As to certain Administrative Arrangements.*

(*a.*) The number of beds should be diminished, and in the surgical wards they should be diminished to one half, the beds to be placed on the window side of the ward, the opposite side being left unoccupied. This arrangement would in the narrower wards leave an interval of 11½ feet, and in the broader wards of 13 feet, between the ends of the beds and the opposite wall, giving a space which is not greater than the vacant floor space in newly constructed metropolitan hospitals.

(*b.*) Provision is required of proper impervious vessels for the reception of the dressings removed from patients and of fouled linen, pending their removal from the ward offices and destruction or cleansing.

(*c.*) Regulations are needed for the guidance of the resident medical staff on the admission of cases of probable traumatic infection, such as I have described in a previous paragraph (p. 101).

Although there was little in the ward management that struck my attention unfavourably during the inquiry, in view of the facts noted in the two preceding paragraphs I venture to suggest, for the consideration of the medical staff, whether that nicety of management, which is the great safeguard of surgical wards, has been secured so fully as they have desired.

(*d.*) It is not only requisite that the general registers of the Infirmary should be kept fully and accurately (and to this end a Registrar was appointed while this inquiry was in progress), but it is also requisite that a special register should be kept of the infectious diseases, traumatic and other, originating or introduced into the hospital, whether among patients or attendants. Unless this be done, and the different facts necessary to understand the source of the infectious malady are recorded at the time, it is impossible to know whether the necessary tendency to fouling of the wards is duly controlled, and the liabilities to infection kept in check. This register should be submitted to the Weekly Board and to the medical staff at each of their meetings.*

(*e.*) Carefully drawn plans of the drainage and the water supply should be prepared, and at all times accessible in the Infirmary. The drainage plans should show the position and indicate the nature of every trap and ventilation aperture. It is a useful practice to have these plans suspended, for ease of reference, in the Board Room, or in the Secretary's Office.

(*f.*) The Manchester Royal Infirmary is fortunate in having a Medical Superintendent who exercises a general control over the sanitary state of the building. To the existence of this office, and especially to its present incumbent, it is owing that the mischievous effects of the different structural and other sanitary shortcomings, described in this report, have not been even more serious than the records show. But I venture to suggest that the house surgeons and house physicians should, subject to the control of the Medical Superintendent, be made definitely responsible for the sanitary regulation of the wards and ward-offices under their charge.

4. *As to other questions.*

(*a.*) I entertain a very strong opinion of the unwisdom of a Dispensary with its out-patients' rooms, and of a dead-house and post-mortem room, being situated within a building largely devoted to surgical purposes, the Dispensary having direct communication with the building. I think it unwise also that a large general laundry, even when managed so excellently as that of the Manchester Infirmary, and a special bandage laundry, should be so closely contiguous to surgical wards. The Dispensary and the dead-house and post-mortem room should be in detached buildings, and the laundry should be removed elsewhere. The bandage laundry should be done away with, and fouled bandages should be burnt.

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* "It ought to be accepted as an axiom in hospital management, that any *concurrence of cases* of traumatic infection originating within the hospital, or any spreading of febrile or other contagion to even a single *patient* within the hospital, is conclusive reason for inquiring whether the fundamental difficulty of hospital management [to wit, the maintenance of due ventilation and of such details of practice conducive to the fastidious and universal cleanliness before described] has not been here unskilfully met."—Simon, *Sixth Report*, p. 65.

(*b.*) The drains of the building should not serve as outlets for the waste steam of the laundries and boiler-house. This should be got rid of in some other manner.

It will have been observed that the recommendation made to diminish by one half the number of the patients in the surgical wards would still further lessen the already overtaxed ability of the Trustees to satisfy the demands made upon the Infirmary. As I have before stated, an amount of work appears to have been continuously thrown upon the Infirmary beyond its sanitary capacity. This undue pressure upon the resources of the Infirmary has been a main cause of its unwholesomeness. If, on the one hand, the recurrence of epidemics of fatal hospital maladies within the wards, and the constant liability of the wards to these maladies is to be avoided with certainty, the diminution in the number of beds which I have advised is, I believe, essential. If, on the other hand, the work of the charity is to continue of its present magnitude, and provision is to be made for its future increase, a considerable addition to the ward accommodation of the Infirmary will be needed either on the present site or on some other site. It is desirable that this consideration should be had in mind in discussing the foregoing recommendations. Whether the necessity of such addition (for I apprehend that any restriction of the beneficent labours of the Charity, on the one hand, or the perpetuation of the present unfavourable conditions under which it works, on the other, is practically inconceivable) renders it unadvisable to continue the existing building is a question which is not within the province of this report to discuss. My duty is ended with this reference to it.

NOTE I.

Registered Cases of Traumatic Infections occurring in the Royal Infirmary, Manchester, during 1875, and to the 12th June 1876.

—	Injury for which Patient admitted.	Secondary Affection.	Ward.	Surgeon.
1875.				
January	Scalp wound	Erysipelas	White	Mr. Heath.
February	Compound fractured leg	Do.	Do.	Mr. Southam.
	Smashed leg	Do.	Albert	Mr. Bowring.
March	Do.	Do.	Do.	Do.
April	Lacerated scalp	Do.	President	Do.
	Secondary syphilis	Do.	Job Hindley	Do.
May	Fractured leg	Do.	Treasurer	Mr. Heath.
	Morbus coxæ	Do.	Mosley	Mr. Lund.
June	Compound fractured leg	Do.	President	Mr. Heath.
August	Do. do.	Septicæmia	Do.	Do.
	Diseased bone	Do.	Dauntesey Hulme	Do.
	Epithelioma, leg	Erysipelas	Jenny Lind	Do.
	Ununited fracture	Do.	Job Hindley	Mr. Lund.
September	Diseased elbow joint	Do. (hand)	Mosley	Do.
	Fractured fibula	Do.	Treasurer	Mr. Bowring.
	Enchondroma of stump after Symes' operation.	Do.	Jenny Lind	Mr. Heath.
	Lipoma, groin	Do.	Humphrey Nichols	Mr. Bradley.

—	Injury for which Patient admitted.	Secondary Affection.	Ward.	Surgeon.
1875. October	Diseased elbow joint	Erysipelas	Jenny Lind	Mr. Bradley.
	Diseased tarsus	Do.	Do.	Do.
	Sarcoma, tibia: *Amputation*	Do.	Dauntesey Hulme	Mr. Heath.
	Fractured skull, left leg, and arm.	Do.	Alice	Mr. Lund.
	Ulcer, leg	Do.	Humphrey Nichols	Mr. Heath.
	Lacerated scalp	Do.	Mosley	Mr. Bowring.
	Traumatic aneurism (femoral).	Septicæmia	Job Hindley	Do.
	Gangrene, toes	Erysipelas	Jenny Lind	Do.
November	Compound dislocation, tarsus.	Do.	Treasurer	Mr. Bradley.
	Compound fracture, tibia	Do.	Alice	Mr. Heath.
	Do. do.	Do.	Do.	Do.
	Compound fractured leg	Pyæmia	Do.	Do.
	Ruptured urethra	Do.	Treasurer	Mr. Lund.
	Compound fracture, olecranon.	Erysipelas	Alice	Mr. Heath.
	Dislocated ankle	Do.	Humphrey Nichols	Mr. Bradley.
	Lacerated forearm	Do.	President	Do.
December	Lacerated scalp	Do.	Do.	Do.
	Compound fracture, forearm.	Do.	Humphrey Nichols	Do.
	Contused wound, scalp	Do.	Do.	Do.
	Compound fracture, frontal bone.	Do.	President	Do.
	Compound fracture, arm	Do.	Do.	Mr. Lund.
	Contused wound, scalp	Do.	Job Hindley	Mr. Southam.
	Contused back and side	Do. (leg)	President	Mr. Lund.
	Burn, face and arm	Do.	Byrom	Do.
1876. January	Scirrhus, breast: *Operation.*	Do.	Jenny Lind	Mr. Heath.
	Chronic Synovitis, knee	Do. (face)	Alexandra	Mr. Bradley.
	Fractured fibula	Do. (leg)	Treasurer	Mr. Lund.
	Necrosis, tibia	Do. (leg)	Jenny Lind	Mr. Bradley.
	Caries, os calcis	Do. (foot)	Job Hindley	Mr. Bowring.
	Scirrhus, breast	Do.	Jenny Lind	Do.
	Lacerated wounds, axilla and knee.	Do.	President	Do.
	Lacerated wound, face	Do.	Alice	Do.
	Urinary fistula: *Perineal Section.*	Pyæmia	Dauntesey Hulme	Mr. Heath.
	Lacerated wound, forehead	Erysipelas	Alice	Mr. Bradley.
	Lacerated wound, leg	Do. (face)	Humphrey Nichols	Do.
February	Amputation, leg	Do.	Do.	Do.
	Compound fracture, leg	Do.	Treasurer	Do.
March	Caries of femur: *Operation.*	Do.	Humphrey Nichols	Do.
	Caries of tibia: *Operation*	Do. (leg)	Job Hindley	Mr. Bowring.
	Smash (compound) shoulder: *Amputation.*	Do.	Peel	Mr. Heath.
	Fractured base of skull	Do. (face)	Treasurer	Mr. Bowring.
	Compound fracture, leg	Septicæmia	President	Mr. Bradley.
	Do. do.	Erysipelas	Dauntesey Hulme	Mr. Heath.
	Simple fracture, leg	Do.	Louise	Do.
April	Cancer of testicle: *Operation.*	Do.	Albert	Mr. Lund.
	Fractured thigh	Do.	Dauntesey Hulme	Mr. Bowring.
May	Strumous disease, knee joint: *Amputation.*	Do.	Jenny Lind	Do.
	Compound Pott's fracture	Do. (leg)	Dauntesey Hulme	Mr. Lund.
	Contused scalp wound	Do.	Mosley	Do.
	Fractured fibula	Do.	President	Mr. Bowring.
	Compound fracture of tibia and fibula.	Do.	Mosley	Do.
	Ulcer, foot	Do.	Alexandra	Do.
June to the 12th.	- - - -	Phlegmonous erysipelas, knee. (Doubtful whether admitted for this affection.)	President	Do
	Punctured wound, radial artery.	Erysipelas	Alexandra	Do.
	Caries, tarsus	Do.	Job Hindley	Mr. Bradley.

N.B.—It is uncertain whether all surgical operations performed in the above cases have been registered.

NOTE II.

In consequence of the state of things disclosed by the inquiry, I thought it necessary, in view of the immediate exigencies of the case, to submit the following recommendations to the Medical Committee:—

1. That a temporary separate building or a tent should be provided within the precincts of the Infirmary, with a separate nursing staff, for the immediate isolation of cases of erysipelas or of other traumatic infection occurring in the Infirmary, and which are not in a state for removal to Monsall; and that arrangements be made to prevent, for the time being, association between the nursing staff of the separate building or tent, and the nursing staff of the surgical and medical wards.
2. That the state of the drains of the Infirmary requires immediate attention, this state having probably exercised a very important influence in the determination of the late and present persistence of fatal traumatic infections in the surgical wards. But, having regard to the excessive foulness, and to the radically bad design and construction of the drains, the necessary work of cleansing and reconstruction cannot safely be effected while the patients and resident staff remain in the Infirmary.

   It is suggested that, perhaps, as least interfering with the usefulness of the Infirmary, arrangements might be made for the removal of the cases and staff to Cheadle, and for the provision of necessary additional temporary accommodation there, including an isolated ward for traumatic infections, so much of the Infirmary only being retained in use during the process of drain cleansing and reconstruction as is absolutely necessary for casualties.

23 June 1876. J. N. R.

These recommendations were adopted by the Committee, and communicated to the Weekly Board. Arrangements are now being made for carrying them into effect.

NOTE III.

EXTRACT from MR. ROGERS FIELD'S REPORT on the DRAINAGE of the ROYAL INFIRMARY, MANCHESTER, dated September 21st, 1876.

Plan of drainage inaccurate.

. . . In order to ascertain with certainty the present condition of the drainage, I had a large number of openings made both inside and outside the building, and from these it soon appeared that the sketch plan of the drains supplied to me was extremely inaccurate, often in very important particulars. For example, the drain from the post-mortem room, which on the plan referred to was shown to pass outside the building, was found really to pass *inside* for its entire length along the corridor underneath the surgical wing. I therefore found it necessary to have the plan revised. . . . . It is certain, however, from discoveries made during the examination, that there are still many inaccuracies which nothing but a complete opening up of the drains from end to end will ever enable to be set right.

Two outfalls for drainage.

The drainage of the Infirmary appears to have two outfalls only, so far as could be ascertained—one into the Market Street sewer, and the other into the Parker Street sewer.

Market Street outfall.

The outfall into Market Street takes the chief part of the Infirmary drainage, and consists of an old-fashioned oval drain of large dimensions. I personally entered and examined this drain by means of the manhole where it leaves the building, and from this examination and the report of the Corporation Surveyor, it appears to be in fair condition, and the levels taken show that it has a good fall. Though, however, the outfall drain itself was on the whole satisfactory, its connexion with the system of drainage from the Infirmary was by no means so. This connexion consisted of a large "dip trap," probably constructed with a view of preventing the sewer gas from the town sewers entering the Infirmary drains. Upon the injurious effect of this trap in confining the foul gases beneath the building I shall have to speak further on. I may at once state, however, that the construction of the trap is such that it forms a cesspool for retaining solid matter, and that when examined by myself and my assistant on two different occasions, this cesspool was full of most filthy deposit. It will be seen, therefore, that the trap is in reality a generator of foul gases, and only adds to the evil it was intended to prevent.

The outfall into Parker Street sewer is an old square brick drain, and when opened at the back of the laundry was in a very bad condition, with a large amount of very foul deposit. I was unable to ascertain exact particulars about the *Parker* Street sewer, but from such information as I could get it would appear that the fall of the Infirmary drain was only moderately good.

Parker Street outfall.

Internal drainage.

Proceeding now to the internal drainage of the Infirmary, I will not trouble you with more details than I can help, but will state the general result of my examination, with a few only of those particulars which appear necessary to make the matter clear.

Conditions of drains very bad.

The drains are, almost without exception, old square brick drains with flag tops, sometimes with flat bottoms, and sometimes with the "inverts" or bottoms slightly rounded. Owing to the inaccuracy of the plan it was impossible to ascertain with any precision the falls of the drains, but they are certainly very irregular and many of them slight. In nearly every place examined the smell was very bad, especially on the drain being first opened. The amount of deposit formed was very variable—in some places little or none at all, and in others very considerable. Speaking generally, the drains on the west side of the building (that is to say, those nearest the Market Street outfall) were comparatively clear, and those on the east side of the building (farthest from this outfall) were very foul. The drain under the corridor near the servants' and nurses' bedrooms in the basement was especially bad, and, in fact, in as foul a condition as I have ever seen any drain. This drain was about half full of deposit (in places even more than this), and the smell was perfectly intolerable. At one point two lead pipes were found with open ends dipping into the slime; it could not be ascertained where these pipes came from, but they were supposed to belong to an old sink or sinks now removed, and if so it is impossible to say what harm they may be doing by conducting sewer air into unsuspected places.

Foul dip-traps.

In addition to the dip-trap on the main outfall drain to Market Street, already alluded to, there are many other traps of faulty construction which retain foul matter. In one case particularly I found a dip-trap at the foot of a soil pipe. A trap of this kind is, as already explained, always more or less of a cesspool; and the case referred to was no exception to the rule. It need hardly be pointed out that to place a cesspool immediately at the foot of a soil pipe is a grievous error. Every time the closets are used the foul matter in the cesspool is churned up, liberating fœtid gases in the soil pipe, whence they will probably find their way into the house. In the case of the Infirmary this result must inevitably ensue from the absence of ventilation in the soil pipes, which will hereafter be referred to.

Water pipe in drain.

On the west side of the house, at a spot underneath the window of the storekeeper's room, was found a lead water pipe, which passed directly through a drain just at the point where a soil pipe from closets on the upper floor discharged into the drain. The pipe appeared as if purposely bent down to enter the drain, when there was not the slightest reason why it should not have taken another course. On investigation it was found that this pipe was charged with water, and was in direct communication with the general supply of the house. I need hardly say that a more abominable arrangement could scarcely be devised, for whenever the pressure in the pipes is relaxed, either through their being emptied for repairs or from other causes, foul gases, and even sewage itself, would infallibly enter the pipe if the slightest leak existed, and might thereby contaminate a part, if not the whole, of the drinking water of the establishment. That such leakage is not an impossibility is shown by the fact that the plumber who made the hole by which the lead pipe was tested closed the same with a wooden plug, and, on my remonstrating, stated this was the method he usually adopted, and that there were a number of holes closed in this way in the Infirmary. It need hardly be pointed out that the rotting of such plugs must sooner or later ensue, and leakage consequently take place.

Steam in drains.

In nearly every case the drains, when opened, were found to be more or less charged with steam, and in many cases the amount of steam was so great as to render the inspection a matter of great difficulty. This steam appeared to come chiefly from three sources, viz., from the steam engine (the exhaust from which goes into the drains), the bandage washing room, and the laundry. In the case of the bandage room the steam came forth with such force from the "eye" communicating with the drain under the room that it was impossible even to look into it.

Rat-runs.

Rat-runs exist in many places, and rats infest the premises. To what extent these runs communicate with the drains it is of course impossible to say with certainty; but I have not the slightest doubt, from what I saw, that such communications do largely exist. For instance, on one occasion, on lifting the iron covers over the water pipe running parallel to the drain on the east side of the centre quadrangle, steam issued, accompanied by a foul smell, showing that a communication existed between the channel in which the pipe lay and the drain. Rats were also seen in the drain close to this point.

Absence of ventilation.

The drains appear to be almost absolutely without ventilation, the only exception being some small air pipes at the top of the soil pipes, which from their size and construction are practically useless.

I will now proceed briefly to describe the internal sanitary arrangements.

Water-closets badly placed.

The water-closets are in many cases very badly situated in the centre of the building, especially those on the basement and ground floor. Two of these, if not more, were practically without ventilation of any kind, and the air in them was stifling and unbearable. The apparatus is in many cases defective, and it is only in a very few instances that separate cisterns are provided. The soil pipes are prolonged upwards through the roof, but terminate in a most extraordinary manner. In every case the soil pipe is carried actually into the main cistern which furnishes the general water supply, and ends in a moveable vertical coil, forming a trap below the water line of the cistern. Into this coil (which can be lifted out of its seat to empty the cistern) there are two openings, one to act as an overflow for the cistern, and the other to receive the rain water from the roof. The small air pipes already referred to are connected to the soil pipes just below the above-mentioned coil. These air pipes are generally about ⅝in. diameter, and are carried horizontally or by a very tortuous course into the open air. It need hardly be stated that a ⅝in. pipe is so utterly insufficient to ventilate the 4 in. soil pipe (40 times its area) that there may be practically considered to be no ventilation at all.

Soil pipes terminate in water cistern.

Bad condition of out-patients' closets.

I must specially refer to the out-patients' closets, which are exceptionally bad. Their situation would not be objectionable were it not that they are directly beneath the steps by which the out-patients have access to the Infirmary. The constructive details, however, are most faulty, and the general condition of the closets is so foul as to render them almost unapproachable. They are intended to be what are known as trough closets, but the iron trough under the seats, instead of discharging its contents directly into the drain, is emptied into a cesspool beneath the trough, which cesspool communicates by a valve with the drain. The iron trough is supposed to be emptied and flushed into the cesspool every day, and the cesspool emptied and flushed into the drain every two or three months. The complete operation was carried out during the progress of this investigation, and will not be forgotten by anyone that witnessed it.

Waste pipes connected directly with drains.

The sinks, baths, and lavatories are all connected directly with drains or soil pipes, and it is even doubtful if some of them have any traps on their waste pipes. In one or two cases the traps are rendered useless by careless arrangements.

Overflows to cisterns pass into soil pipes.

The overflows from the cisterns, as already stated, pass direct into the soil pipes. The cisterns themselves are of lead and uncovered, and the rain water passes over them in open gutters which discharge into the soil pipes, terminating in them as already described. In most cases the same cisterns are used for water-closets and the general supply.

Post-mortem room and dead-house in bad position.

Though strictly more a medical than an engineering question, I think I ought to refer to the positions of the post-mortem room and dead-house. Both appear to me to be badly situated, especially the latter, which is completely under the surgical wing.

No. 6.

App. No. 6.

On Effluvium-Nuisances, by Dr. Ballard.

Report in respect of the Inquiry as to Effluvium-Nuisances arising in connexion with various Manufacturing and other Branches of Industry, by Dr. Ballard.

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INTRODUCTION.

ON April 6, 1875, Mr. Simon, at that time Medical Officer of the Board, brought before the President a proposal that I should be charged with the large inquiry on which the following is my first report,—a general inquiry, namely, which I was to carry on at such times as my other office-engagements would allow, into "the effluvium-" nuisances which arise in connexion with various manufacturing and " other branches of industry, specially with regard to the effect upon " health of each such nuisance, and to the degree in which the nuisance " can be prevented;" and the President having approved this proposal, I thereupon received my instructions from Mr. Simon, and I commenced the inquiry in November 1875. From the nature of the inquiry it has been impracticable to pursue it in any systematic order. It has been necessary to make inquiries, and to visit establishments of the same kind of business, in many different places; and, on the same day, perhaps, to visit various kinds of business establishments in the same place. I am by no means sure that all branches of industry producing effluvium nuisances are included in the report; but I think it will be found that all the most important of them are included. And as respects the remainder, I think it will probably be found that the principles enunciated as respects those industries reported on are applicable *mutatis mutandis* to those which may have been omitted, whether regard be had to the nature of the effluvia and their effect upon public health, or to the means which may be suggested for the abatement or minimizing of the nuisance created. The magnitude and difficulties of the subject were obvious as soon as it was fairly entered upon.

In order to avoid periphrasis I shall throughout this Report designate manufacturing and other branches of industry producing effluvium-nuisances "offensive businesses," and the nuisances they occasion "industrial nuisances."

In pursuing the inquiry I have endeavoured to obtain information upon the following points, viz.:—

1. The extent and degree of the inconvenience to the community occasioned by industrial nuisances.
2. The industrial processes, or the parts of industrial processes, which produce effluvia complained of as offensive.
3. The evidence that these offensive effluvia are also injurious to health.
4. The methods which are in use or may be devised for preventing or minimizing nuisance from them.
5. (Incidentally.) The difficulties experienced by local authorities in dealing with this class of nuisances.

The only observations of a general character I propose making at present are the following. The tendency of the inquiry is to show that,

Extent and degree of public inconvenience.

I. While certain kinds of offensive businesses are to be met with and occasion nuisance mainly in certain known localities, the majority of them are scattered more or less widely over the country, and one or more of them are to be met with usually in every town and in some villages. For various reasons, these nuisances are not always made the subject of complaint to local authorities, even where the nuisances are pretty constant, but the annoyances, and sometimes serious annoyances, exist nevertheless. I soon discovered that the frequency of complaints made to the local authorities was no trustworthy criterion of the extent or intensity of a nuisance. Several causes conduce to this. In the first place there is the thoroughly English and praiseworthy disinclination to be unneighbourly. English people living in the same town or village will bear a great deal of annoyance from those with whom they live in amity before they complain to any constituted authority, especially if they think that such complaint will lead

Complaints to local authorities no trustworthy criterion.

to legal proceedings in which they are likely to be called to give evidence. This feeling operates decidedly more in small towns and villages, where the inhabitants are much thrown together socially, than in large towns or in London. In the second place it sometimes happens that the person whose trade creates the nuisance is the principal and most important man in the place, and abstention from complaint results from a dread of his influence being exerted adversely to the complainant. Allied to this last is a third cause. It sometimes happens that the persons most annoyed are those who are either directly or indirectly dependent for their livelihood upon the existence of the establishment, or class of establishments, creating the nuisance. Such persons are not at all likely to complain, however great the annoyance they experience. In the fourth place, it sometimes happens, from one cause or another, that persons annoyed by trade effluvia abstain from making complaint, because they are unable distinctly to associate the nuisance they suffer from with a particular establishment. This often occurs where offensive businesses of the same or of different kinds are congregated in or about some particular spot. When they are of the same kind complaint is sometimes made generally of the group of establishments; where they are of different kinds, the persons who would be disposed to complain are not sufficiently informed to be able to distinguish between the different effluvia. Habitual exposure to trade effluvia and constant daily familiarity with them tend, as is the case with all offensive odours, to render people less sensitive to their influence, and thus less disposed to complain of them than they otherwise would be. I have often myself experienced this loss of sensitiveness in the midst of the most offensive trade processes.

Habit, &c. affect sensitiveness to ill odours.

To a similar cause may probably in part be attributed the fact, that a nuisance is sometimes less complained of in the immediate vicinity of a trade establishment than at a distance from it, where the effluvia are only occasionally wafted by the wind. It is no criterion of the existence or intensity of a trade nuisance that it is not complained of in the immediate purlieus of an establishment; so it is no valid ground for disbelieving the assertions of those who complain, although living at a distance.

Some individuals, moreover, are more sensitive to offensive odours than others; for personal habits of life and the habitual surroundings of persons in different social positions, while they may cause some to feel distress and inconvenience from comparatively trifling degrees of stench, may render others little observant of comparatively intense offensiveness.

Degree of nuisance varies with nature of trade.

The degree of nuisance occasioned by offensive businesses varies greatly with the nature of the businesses. The most offensive effluvia are those which are given off from trade processes in which the materials used consist mainly of animal matters, especially refuse animal matters, or which contain elements of animal origin. The most disgusting of all are the effluvia from the process of gut scraping and the preparation of sausage skins and catgut, the preparation of artificial manures from "scutch" (the refuse matter of the manufacture of glue), the manufacture of some other kinds of artificial manures, and the melting of some kinds of fat. Manufacturing businesses which deal with vegetable substances are often very offensive, but only rarely can be said to give rise to disgusting effluvia. Among the most offensive are those in which effluvia are thrown off during the heating of vegetable oils, as, for example, during the boiling of linseed oil, the manufacture of palmitic acid from cotton-oil foots or palm oil, the manufacture of some kinds of varnish, the drying of fabrics coated with such varnishes, and the burning of painted articles, such as disused meat tins. Among the trades which deal with materials which are neither animal nor vegetable substances, the most offensive effluvia proceed from the manufacture of ammonium sulphate or chloride, and some other processes and manufactures in which a copious evolution of sulphuretted hydrogen occurs, and from gas making and the distillation of tar. Public attention has of late years been called to the nuisance arising from the manufacture of alkali and bleaching powder. The fumes proceeding from works of this kind are acid and irritating, and to most persons offensive; but the chief complaints about them have relation to the injury they inflict upon vegetation in the neighbourhood of the works. This has been and unquestionably still is, although probably to a less degree than formerly, severe. I do not find that persons who have no property to be injured by the fumes complain very much of their mere offensiveness. No doubt these fumes are very distressing to persons unaccustomed to an atmosphere in which they are largely diffused (they are distressing to myself), but for most persons custom greatly attenuates the nuisance, so that it is little noticed by persons residing in the towns where such works as these are principally congregated.

Extent and degree of nuisances vary with locality, weather, &c.

Various circumstances of locality and surroundings, wind, weather, &c., modify the extent to which such nuisances spread and their degree. The distance from works giving off offensive effluvia, at which their effluvia are a source of nuisance, varies greatly, from a few yards to several miles. This partly depends upon the nature of the effluvia, partly upon the elevation at which they are discharged into the atmosphere, and the elevation of the surrounding neighbourhood, and partly upon conditions of weather. Thus, effluvia which consist of vapours of high density and little diffusive capacity do not, as a rule, travel so readily to a distance as those which are less dense and more easy of diffusion, but the very fact of more ready diffusibility attenuates while it extends the nuisance. My own observations induce me to think that the distance at which trade effluvia create nuisance depends very much upon the other conditions I have mentioned. Thus, effluvia discharged near the ground are more likely to produce annoyance in the immediate neighbourhood of works than at a distance from them. On the other hand, when effluvia are discharged at a considerable elevation, their offensiveness is usually scarcely, if at all, perceptible close to the works, but at a greater or less distance from them. Hence it occurs that immediate neighbours may be relieved from annoyance by carrying an offensive vapour into a tall chimney shaft, but often at the expense of persons living at a distance. Again the surroundings of the works may make a difference. Thus, in the open country where there is nothing to impede the free travelling of vapours through the air, their offensiveness may be a source of inconvenience to persons living at the distance of one or more miles, even although the vapours may be discharged at the surface of the ground, or little above it; whereas similar vapours similarly discharged in a town, or in places where their passage through the air is obstructed by buildings or other impediments, may only give offence to persons residing within the limits of these impediments, as, for instance, in the same street with the works or in adjoining streets or courts along which the vapours may have free course. For the same reason it may happen, when the effluvia are discharged from a chimney shaft, that a hill or rising ground at a greater or less distance may intercept their course, and that the offensiveness may be perceived on the side or summit of the hill, and not at its base, nor yet on low ground at a similar distance from the works in another direction. Hence, the height of the chimney from which the discharge takes place will, in places where there is irregularity of the surrounding country, influence considerably the distance and the precise localities in different directions in which the offensiveness is perceived. The amount of moisture in the

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On Effluvium-Nuisances, by Dr. Ballard.

atmosphere and the direction and force of the wind also modify the distances to which offensive effluvia will travel, and indeed the intensity of the offensiveness when it is perceived. When the air is saturated with moisture and there is little or no wind, effluvia hang about the immediate neighbourhood of their point of issue, even when discharged at some elevation; they are entangled in the cloud of moisture, and are carried away by it, should the cloud move on, whithersoever the cloud proceeds. A London fog is a familiar illustration of this state of things. Then should there be rain, the effluvia are washed down by it to the ground, the more readily the more soluble they are in water. On the other hand, in clear weather when there is little or no excess of moisture in the air, the effluvia will pass readily to a distance, and be perceptible in the direction in which the air is moving. In a still atmosphere, the effluvia if discharged at a low level, hang and diffuse themselves about the works; but if at a high elevation from a chimney, rise still higher with the heated volume of air to an elevation where they may meet with a current of air driving them slowly in some particular direction; but they then usually undergo considerable diffusion and attenuation before they arrive at the surface of the ground. A high wind, if boisterous, scatters the effluvia, attenuating them at the same time, a long way in its direction; but if not boisterous, but steady, especially if there be some excess of moisture, the effluvia may be carried in a more or less intense form to very considerable distances.

Atmospheric temperature also has something to do with the offensiveness of trade effluvia. Such of these as proceed from the decomposition of organic matters originate more readily in warm weather than in cold, and hence it is that certain trade processes are more complained of in the summer than in the winter months, such trades for example as fellmongering, gut-spinning, blood albumen making, and the sorting and sifting of domestic refuse. But apart from this, there are certain kinds of odours which are less readily tolerated in hot than in cold weather. A striking example of this is the odour of melted fat such as arises from the places where fat is melted for candle or soap-making. The objection to such an odour in the summer is paralleled by a similar objection by most persons to fatty foods and to ordinary kitchen smells at that season.

Difficulties of a scientific classification of offensive businesses.

II. It is difficult to classify satisfactorily the businesses which give off effluvia creating nuisance. Some are very important manufactures, the staple trades of certain neighbourhoods, involving the sinking of large capital in the business and in plant; others are petty trades carried on, perhaps, in the open air, or on a small scale, and involving little or no expenditure of capital; and there are all grades between these extremes. The materials dealt with may be derived from the mineral, vegetable, or animal kingdom, and in some trades from two or all of these kingdoms. A considerable proportion of the nuisance trades consist in the working up and utilisation of refuse matters often of a mixed nature, domestic refuse, town refuse, and trade refuse, and of various offensive matters which it is important to get rid of from populous places, and which are too valuable to destroy.

The chemical nature of the effluvia again cannot be well used as a basis of classification, since, on the one hand, the effluvia are in many cases of a very composite character, and in many other cases undetermined; while, on the other hand, an attempt to do so would throw into the same group such heterogeneous businesses that the classification would be simply pedantic and practically worthless. Equally futile would be the endeavour to classify businesses according to the nature of the injury their effluvia inflict upon persons exposed to them, since, as I shall presently have occasion to show, the injury inflicted by trade effluvia wholly unlike may be very similar or apparently identical, and in any case may vary with accidental circumstances. Lastly, it occurred to me that the practical means of preventing nuisances, or at any rate the principles of dealing with them for the purpose of abatement, might form a ground of classification; but here again I was met by the fact that in scarcely any business was it possible to lay down any one means or even any one principle applicable to secure this object.

The classification adopted based on convenience.

I fall back, therefore, upon a classification which, although crude, has the advantage of being convenient for the purposes of this Report, and I propose to group offensive businesses as follows, viz.:—

1. The keeping of animals.
2. The slaughtering of animals.
3. Other branches of industry in which animal matters or substances of animal origin are principally dealt with.
4. Branches of industry in which vegetable matters are principally dealt with.
5. Branches of industry in which mineral substances are principally dealt with.
6. Branches of industry in which matters of mixed origin (animal, vegetable, and mineral) are dealt with.

In distributing the offensive businesses of which I shall have to treat between these headings, admittedly unscientific, it may appear to some minds that accuracy has also been occasionally lost sight of, and that industries have been placed in one group which in strictness ought to have been placed in another. For any such apparent offence against order, I again advance the plea of convenience.

One, two, or more processes of a trade may be offensive.

In some offensive businesses the material dealt with undergoes but one process, that process giving rise to offensive effluvia. In others, and these by far the most numerous, the raw material is subjected to varied manipulations before it issues in the article of commerce. It may be that each separate step in the process is liable to give origin to an effluvium nuisance, or it may be that one or two only of the processes are open to this charge, the remainder being wholly inoffensive. And when two or more of the processes are thus of offensive character, it may happen, and usually does happen, that the effluvia given off in the different processes are different, both chemically and to the senses, so that from the same establishment offensive effluvia varying in nature and in degree of offensiveness may issue at the same time or at different times. Moreover, it is to be observed that the same branch of industry or manufacture (looking at its designation and final result), is not always carried on in precisely the same way, nor always with precisely the same materials even, by all the persons engaged in it.

Specialities of detail in a trade affect the question of nuisance.

The general principle of the manufacture may be the same, and its broader features may be the same, but expediency, convenience, or the attainment of some special object (perhaps a speciality of the manufacturer) may lead to variations of detail, and these variations may modify more or less the aspect of the business as viewed in its relation to the subject of this Report. And, more than this, such specialities in methods of working have in some instances rendered my task one of unusual difficulty. They rendered necessary a mastering of details, at first sight perhaps trivial and sometimes unexpected, such as could not have been accomplished had I not received the cordial assistance and co-operation of the manufacturers themselves. I do not pretend even after the prolonged inquiry I have made, to have learned all that might be learned in this respect. Nearly every day that I have been engaged in visiting trade establishments something has come to my knowledge which I did not know before, or something which I did know before has acquired in my mind a position of importance which I had not previously supposed to be its due. Hence it may happen that a feeling of disappointment may now and then arise in the mind of one referring for information to this Report. He may fail to find the particular piece of information that he needs. He would probably be in no better position were my inquiry still further protracted, not only because new processes are continually being adopted for carrying out new inventions, but because established businesses are constantly liable to modification in the method of conducting them (as for instance, in consequence of the varying value of materials capable of substitution the one for the other), either by the introduction of new methods or by the re-introduction of methods previously abandoned. I have had to content myself with describing processes of established businesses as I have in the course of my inquiry seen them generally pursued, adding, where essential to my object, a description of any peculiarities of process which have appeared to me to be important. Technical descriptions of businesses must always be difficult to one not engaged in the actual businesses, but in respect of several very important manufactures the difficulty which I naturally experienced has been overcome by the kind assistance, readily accorded me, by some of the most distinguished manufacturers, who at my request carefully read through such of the proof sheets as related to their trades, and suggested various corrections and amendments which were essential to accuracy.*

Are offensive trade effluvia injurious to health?

III. It is still more difficult to determine to what extent offensive trade effluvia are to be regarded as injurious to public health. The method to be adopted to settle this point (so far as it is capable of being settled), was the subject of conversation between the late Medical Officer of the Board and myself when the inquiry began. We agreed that any valid statistical investigation was quite impracticable, partly on account of the enormous labour which it would have involved and the consequent protraction of the inquiry to a period altogether undeterminable, but mainly on account of the obstacles, at present insuperable, to eliminating the influence upon health of other circumstances (some known or knowable, others unknown and unknowable), the influence of all of which, however, would have, one by one, to have been eliminated had this method been adopted. It was clear that the only method open to me consisted in such inquiries addressed to individuals as I might have opportunity of making, and in gathering up, and valuing on the spot, the opinions on the subject held by medical men, and especially by medical officers of health.

"Injury to health." What does the term mean?

More than one definition of the term "injurious to health," and more than one criterion of such an influence being in any case exerted, may be suggested.

(*a.*) It may mean that exposure to the offensive effluvia causes bodily discomfort or other functional disturbance continuing or recurring as the exposure continues or recurs, and tending by continuance or repetition to constitute (though, perhaps, not a clearly defined form of disease) an appreciable impairment of general health and strength.

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* Although, on the completion of my Report, I shall have the pleasure of tendering my thanks to those gentlemen by name who have often, at much personal inconvenience I fear, given me generally their assistance in my inquiry, I ought not to defer mentioning those manufacturers who have assisted me in this particular way in respect of the earlier portion of my Report, viz., Mr. Wm. Vickers, bone boiler, size maker, soap manufacturer, and manure manufacturer, of Manchester and Widnes; Mr. Turney, leather manufacturer, of Nottingham; Mr. George Gilligan, tanner, of Reading; Mr. Freeman Wright, glue manufacturer, of Needham Market; Mr. Newland, of Mr. James Duncan's sugar refinery, Victoria Docks; and Mr. McDonald, of Poynter's animal charcoal works, Greenock.

(*b.*) Or it may mean that persons exposed to them are more deeply and more definitely damaged in health; that their lives are shortened, or pursued in chronic ailment; that they are rendered more liable than other persons to the invasion of definite forms of disease; or that diseases are with them apt to run a less favourable course than with other persons.

I am not quite sure that these two definitions, which I have ventured to attempt, do not somewhat overlap one another, since, after all, what we mean when we speak, in common parlance, of an impairment of general health and strength, does really involve definable systemic alterations, say in the blood or nervous system, due often to recognisable antecedent conditions. But for practical purposes they may be allowed to suffice, especially as my meaning may become clearer as I proceed to illustrate it.

(*a.*) Functional disturbance due to impressions made on the senses.

(*a.*) The first definition is applicable to those cases in which functional disturbances unquestionably arise as the result of the impression made by offensive effluvia upon the senses. Persons in the best of health may suffer such disturbances from very brief or temporary exposure, the amount of disturbance varying with the sensitiveness or peculiar constitution of the individual, and the distressing symptoms may last long after the exposure has ended. An instance of such deep impression came under my observation last summer in the case of a personal friend who, after accompanying me without suffering in any way, in my visits to some offensive trade establishments, acquired a very severe headache within a few minutes of exposure to the effluvia proceeding from the boiling of Esparto grass in a paper manufactory. The headache was so severe that he said he wished himself dead, and it lasted severely all night and had not disappeared the following day. Probably what is called idiosyncrasy was concerned here; and as this gentleman suffered from exposure to one particular effluvium, so other individuals may suffer from other kinds of effluvia which are not productive of definite injury to people in general. Usually such disturbance terminates with the exposure or shortly afterwards. With sick persons, however, it may be otherwise, and sick persons necessarily form part of the various populations which may be exposed to the offensive effluvia from trade establishments. Such persons, sometimes in consequence of their state of ill health, are apt to be more sensitive than healthy persons to impressions on the senses, they may proportionally suffer more distress from offensive impressions, and their recovery may be retarded thereby. I myself, when in practice, saw a case in which serious vomiting with hæmorrhage was induced more than once most distinctly by the offensive smell proceeding from a group of offensive business establishments. The person who thus suffered was a lady subject to hæmatemesis, and she finally died from the hæmorrhage. And further, it is worthy of remark and instructive how constantly, in records of proceedings in courts of law and as the result of my own individual inquiries, one particular group of symptoms is mentioned as the most prominent of those resulting from exposure to offensive trade effluvia, and how uniformly this group turns up, whatever difference there may be chemically, or as appreciable by the senses, in the nature of particular effluvia. This group consists of loss of appetite, nausea, sometimes actual vomiting, sometimes diarrhœa, headache, giddiness, faintness, and a general sense of depression and *malaise*. And since these different kinds of effluvia have nothing in common except their offensiveness, it is difficult to avoid the inference that the symptoms mentioned have their origin in the impression they make on the senses. If health consists, among other things, in the easy, painless, imperceptible performance of the bodily functions (as under any definition it must do), it can scarcely be held that such disturbances as those enumerated, which are quite inconsistent with ease and comfort, but are more or less painful and decidedly abnormal, do not constitute when they are present a condition of ill health—of *dis*-ease, of *mal*-aise—or that offensive effluvia, exposure to which brings about such disturbances (whether of longer or shorter duration) are not in that sense injurious to health, even if the duration of the bodily disturbance is brief. *A fortiori* such effluvia must (I venture to suggest) be held to be injurious to health when, by repetition of the functional disturbances referred to, bodily strength wanes, when habitual lassitude usurps the place of habitual energy, and when, with this, the general feeling of mere enjoyment of living, which thoroughly healthy people experience, languishes.

(*b.*) Deeper and more serious disturbances of health.

(*b.*) But whatever doubt there may be (if there be any) as to the validity of the first definition, there can be none as to the second. The difficulty lies in demonstrating its applicability to trade effluvia as productive of the conditions mentioned. If I were writing about the influence of trade effluvia upon the health of workmen (which is not the case) I should have no difficulty at all in the matter, for I might adduce the occurrence of definite forms of disease or actual poisoning among workmen in certain trades, as for instance, among workmen exposed to the concentrated fumes of phosphorus or arsenic, to atmospheres largely charged with sulphuretted hydrogen, chlorine, carbonic acid, &c., or with the exhalations from decomposing organic matters. But it is a different thing to demonstrate that in the diluted form in which, under almost any circumstances, trade effluvia reach persons outside works, such effluvia produce the serious damage to health that this definition involves. Let us see how far we can go in this direction.

Manufacturers' ordinary line of argument considered.

But first I must dispose of an *a priori* argument commonly put forward by manufacturers and others interested in offensive businesses. I hear it said very often by manufacturers whom I visit, that it is impossible to believe that the offensive effluvia from their works can injure the health of persons outside, because their workpeople, who are exposed to them far more than outsiders, have exceptionally good health. In saying this they refer to injury to health under this second definition. I intend no offence to these gentlemen, for whom I have a great respect, and no disparagement of their veracity, when I say that the invariability of this appeal to the health of their workmen, be the trade what it may, naturally induces one to look somewhat critically at the argument. In the first place, their memories may not always serve them very loyally when they make such a statement, and, if they came to think matters over, they might call to mind some suspicious occurrences which would tend the opposite way. In the second place, although it is quite true that many men engaged in the trade from youth till middle age or advanced age are to be met with in such works, who have never suffered from serious illness attributable in any way to their occupation, it does not follow that others have thus gone scatheless. Men may fall ill after a time, leave their work, "go upon their club," and suffer an illness not recognised at the time as the result of their occupation, yet for all that really due to it, and their masters have no knowledge of the cause of their ill health. Such men are apt to be lost sight of or to change their occupation to some other that they consider lighter work or more healthy. But taking the statement, that the men engaged in these offensive trades do not suffer in health from the effluvia, as absolutely unquestionable, various explanations of their immunity may be suggested. For example, in the best conducted works, where the men engaged naturally prefer to remain, having confidence in their masters and their masters having confidence in them, efforts are mostly made to protect the workmen from the effluvia to which their work would expose them, sometimes by the use of respirators, sometimes by carrying off the effluvia by careful and efficient arrangements to the outer atmosphere, and so on. It has more than once happened in my experience that the effluvia have been much more perceptible outside works than within them by reason of this very carefulness. And, again, it is to be kept in mind that the workpeople are mostly of the age and sex which offer the greatest resistance to the operation of ordinary causes of disease; that when in full work they live well, have plenty of fresh air during the intervals of their work and while going to and returning from it, and little care for the future. All this is protective. It may be, and usually is, otherwise with persons residing outside the works and not occupied in them, with women and with children in their neighbourhood; and it is no argument against trade effluvia being an exciting cause of ill-health among such persons to say that they may, from their home surroundings, be predisposed to suffer. I fear too much space has been occupied in disposing of this argument. The main question is one of fact, and to be solved as far as practicable by observation and experience.

The *a priori* argument.

It must be at once apparent that it is not practicable to apply the pure method of induction to the solution of the present problem. I have myself been unable, in the time at my disposal, to gather together a sufficient basis of unquestionable facts and duly to differentiate the influence of concurrent morbific conditions; and the opinions of medical men, in a position to form just opinions from facts under their local observation, have not been found always to agree in respect of the influence exerted by particular kinds of trade effluvia. The probable cause of these discrepancies of opinion is that all had not made equal use of their opportunities of observation, or had not equally taken into account all the circumstances calculated to modify their beliefs. The method of induction, however, is not the only method which may be adopted in this report. We are at liberty to look at probabilities, and, arguing partly deductively, to take into consideration the question how far offensive trade effluvia can be regarded as falling into some category to which an established axiom is applicable.

Trade effluvia one element of atmospheric insalubrity in towns.

1°. It must be obvious that trade effluvia constitute one item in the long list of circumstances which cause the air of a town to differ from country air, and so, when present, furnish their quota to the general condition of comparative atmospheric impurity which is associated as cause and effect with the comparative insalubrity of towns.

Trade effluvia of septic origin unwholesome.

2°. Distinguishing, now, between effluvia of one kind and of another, one class of effluvia stands out as distinct from the rest, namely, those effluvia which have their origin in the spontaneous decomposition of organic matters and especially of animal matter, the composite elements of which are being broken up under the operation of a septic ferment. The effluvia from such matters are unquestionably dangerous, and, indeed, a fruitful source of much fatal disease. The influence of such effluvia upon the health of persons exposed to them has been fully dwelt upon by Mr. Simon in his Second Report to the Board, from which Report I shall have occasion to quote largely on the first occasion that presents itself of discussing the influence upon health of this class of effluvia as originating from a particular group of businesses. At present I shall content myself simply with saying that the great leading axiom of all public and private sanitation that "filth produces disease" formulated and illuminated by the late Medical Officer of the Board bringing to bear upon it the rays issuing from modern scientific investigation, has an extensive application to the subject matter of this inquiry. It has specially its application to what are *par excellence* filthy businesses—businesses in which are dealt with organic matters in a state of active septic change, or which are on the eve of undergoing such change, or in conducting which, without due carefulness, decomposing organic matter of the nature of filth cannot fail to accumulate and give rise to offensive effluvia. Deductively, the effluvia from such businesses always lie under a strong suspicion of being injurious to health in the sense of the second definition, while in some instances their morbific character must be regarded as absolutely certain.

Trade effluvia containing specific contagia dangerous.

3°. There are certain effluvium-producing businesses dealing with refuse matter, in which some of the refuse matters dealt with are liable to be infected with the specific contagia of infectious diseases. Such effluvia, if charged with infectious matter, cannot fail to be dangerous to persons exposed to this influence.

Definite chemical substances, if irritants or poisons, are dangerous.

4°. The remaining kinds of trade effluvia, so far as the probabilities of their being injurious to health are concerned, may all be considered in one group. They are chemical elements or definite chemical compounds inorganic or organic; some are probably innocuous although offensive, some, even in a diluted condition, irritating to mucous surfaces of the body with which they may come in contact, while others are so decidedly poisonous in their nature that if they were in a concentrated form, they would kill persons exposed to their influence. If, when diluted with air, as they always are outside works, such effluvia are capable, as they sometimes are, of producing in a minor degree their irritating or poisonous effects upon the human body, they must be regarded as injurious to health in the sense of the second definition. But, on the other hand, it has sometimes been suggested that certain of the offensive trade effluvia of this group (such, for instance, as chlorine, sulphurous acid or tar vapours) are actually beneficial to public health inasmuch as they are well-known disinfectants, and are in common use as disinfecting agents. I have over and over again heard manufacturers argue thus: but they do so in ignorance of the fact that, for such disinfecting agents to be effectually operative against any contagium, they must be applied to it in a state of concentration far greater than that of the diluted effluvia met with outside chemical works; and, as respects such as are oxidisers, that they will exercise their oxidising powers upon such dead matter as comes within their reach capable of oxidation, before and in preference to exercising them upon the (presumably) living material of a specific contagium. Of such matter there is in the atmosphere and on the surface of the earth more than sufficient to protect specific contagia from their disinfecting action.

Fallacy of imputing to them disinfecting qualities.

Results of observation and experience.

Reverting now to the results of direct observation and experience, it may be said that, although the statistical argument is practically inapplicable to our purpose, and although there are discrepancies of statement among people professing to observe, there is sufficient evidence at hand to confirm, where confirmation may be needed, the inferences to be deduced from the foregoing considerations, if not enough (as confessedly there is usually not enough) to stand alone as indisputable proof, unsupported by such prior considerations. Offensive businesses are not, as a rule, set down in aristocratic neighbourhoods, and, when they are established, the well-to-do portion of the population does not usually congregate about them. They are almost universally found in neighbourhoods where the poorer and labouring classes lodge—classes of persons who are subjected to a variety of unwholesome influences, filth effluvia, overcrowding of population, scanty or unwholesome food, &c., the influences of which are intermixed with, and, unless occasionally under exceptional circumstances, scarcely distinguishable from, those of the business effluvia in question. Now and then these exceptional circumstances may be present, but they have to be sought out, and, when the opportunity arrives, the man is not always at hand who is capable of availing himself of it, or willing to do so. At p. 134 of this report an instance is given, however, in which (the conditions of inquiry being favourable) the differentiation was effected with a result confirmatory of the probabilities of the case. When trade effluvia carried to a distance through the air chance to reach a population otherwise circumstanced, they are commonly so diluted as to render it very questionable indeed whether ill-health attributable to them is not rather such as falls within the first rather than the second definition.

Opinions have been occasionally broached to the effect that certain infectious disorders have been induced by habitual exposure to certain business effluvia, in cases where the infection could not possibly have come from any previous sufferer with the disease. I have heard this asserted, and instances adduced as respects such diseases as enteric fever and scarlet fever—diseases which, so far as we at present know with certainty, never originate except from a specific contagium reaching an individual by some direct or indirect (often very indirect and obscure) channel from a previous case. Opinions of this kind are obviously without value unless they proceed from persons sufficiently instructed in the established doctrines of etiology, and who have succeeded in disproving current beliefs. But on the other hand it is to be recollected that there are spreading diseases, the contagium of which very probably indeed (in some instances one may say with certainty) may be developed anew under the influence of some kinds of effluvia, such as are liable to issue from some business establishments. Erysipelas and its congener, puerperal fever, is one of these, and some observations I shall have occasion to quote hereafter may raise the suggestion that diphtheria may perhaps be one of them.

Again, there is an opinion held that the spread of infectious diseases once introduced into a neighbourhood is promoted by habitual exposure to offensive trade effluvia. The general condition of health commonly known as being "below par," which habitual exposure to the influence of offensive effluvia may bring about, may very easily be believed to predispose to the reception, or development when received, of a specific contagium and to lessen resistance to its operation. Now, on the one hand, in almost all the alleged instances of this event which have been presented for my acceptance, I was satisfied that other better known conditions calculated to favour spread and to dispose to an unfavourable issue had not been sufficiently passed under review. On the other hand, I have the well-considered opinion of careful observers that they have been unable to trace any operation of the kind in respect of the very effluvia which had been thus accused. I may instance the opinions in this direction given me by Mr. Davies, the medical officer of health for Bristol, in respect of the mixed and very offensive trade effluvia in St. Philip's Marsh, and of Dr. Russell, the medical officer of health in Glasgow, in respect of the trade effluvia at St. Rollox and its neighbourhood.

There is, however, sufficient evidence to show that irritating trade effluvia do sometimes effect mischief, by virtue of their irritating quality, on the persons exposed to them, even at a considerable distance from the works from which the effluvia issue, and after they have undergone considerable atmospheric dilution. Mr. Davies tells me that he thinks it probable that an excess of pulmonary mortality which he has observed in St. Philip's, Bristol, and which is otherwise inexplicable, has been due to this cause. With respect to the poisonous gases, such as arsenical vapours and sulphuretted hydrogen, the evidence of experience in the localities where they are given off from chemical works is conflicting, and not always very trustworthy.

No experience that I have been able to gather tends to confirm the notion that any of the chemical fumes proceeding from alkali or bleaching powder works, or from other works giving forth into the atmosphere supposed "disinfecting" vapours, have ever exerted any influence whatever in preventing or arresting the spread of infectious diseases in the localities where such fumes or vapours are perceptible.

Adoption of means to prevent or minimise nuisances.

IV. In many works in which offensive effluvia are produced, means have been adopted, either voluntarily, or under pressure from local authorities, for preventing altogether, or reducing more or less, the nuisances occasioned by the diffusion of effluvia beyond the works. But there are very many works in which no pains have been taken in this direction. This has partly arisen from want of consideration for neighbours, partly from want of capital and the resulting struggle to make any profit, and partly from the difficulty of disturbing the traditions of the business. The means adopted to prevent nuisance have not always been very efficient, sometimes because the persons consulted by the manufacturer have not always possessed the requisite technical knowledge and experience for advising in such matters, sometimes because outlay of money in the erection of efficient apparatus has been grudged, and sometimes because apparatus, at first probably efficient, has been allowed to become dilapidated. The tendency of the inquiry is towards establishing this point, viz., that all, or nearly all, the trades now causing offence from the diffusion of effluvia may be so carried on as not to cause offence at all, or only offence of such a trifling nature as may well be tolerated by persons who live in communities.

Mostly feasible.

There is no difficulty whatever in laying down the general principles upon which the appropriate means of preventing or minimizing effluvium nuisances from business establishments must be based. In dealing with any particular establishment however, the possible composite nature of the nuisance must not be overlooked. For practical purposes several kinds of origin of nuisance effluvia may be recognised. Thus, a nuisance may be dependent :—

Ordinary sources of origin of effluvium nuisances.

1. On accumulation of filth on or about the business premises, or on its removal from the premises in an offensive condition.
2. On a generally filthy condition of the interior of the buildings and the premises and utensils generally.
3. On an improper mode of disposing of offensive refuse, liquid or otherwise.
4. On insufficient and careless arrangements in the reception of offensive materials of the trade, or in the removal of offensive products either from the premises or from one part of the premises to another.
5. On an improper mode of storing offensive material or offensive products within the works.
6. On the escape of offensive gases or vapours given off during some part or parts of the processes to which the materials of the trade are subjected into the atmosphere outside the works.

In the progress of this report, abundant illustrations will be presented of each of these modes in which effluvium nuisances may arise from business premises. I am now only concerned with the general principles on which their prevention is to be based.

General principles of prevention.

As respects the first and second of these sources of effluvium nuisances, the obvious remedy is "cleanliness" in the broadest sense of the word:—

1. Filth should be removed from the premises speedily in the impervious covered vessels in which it ought always to be collected from time to time during the day.

2. Those parts of the interior of the premises liable to become dirty or encrusted with filth or decomposable matter and all the utensils employed should be regularly cleansed. Such structural and working arrangements should be made as shall not only tend to prevent such defilements, but also tend to facilitate cleansing.

3. Solid offensive refuse should be separated from liquid refuse as far as practicable, and each should be disposed of in its appropriate manner, the solids being deposited and speedily removed in covered impervious vessels, and the liquids being run off into proper drains in such a condition as not necessarily to give rise to offensive emanations. Deodorants may sometimes be used with advantage.

4. Offensive matters necessary for use in the business should be brought upon the premises either in covered impervious vessels, or covered up in such a manner that they shall not be a source of effluvium nuisance during transit; they should be so received in an enclosed building, and unloaded with due precaution against the issue of effluvia in the process. Offensive products should be removed similarly from the premises. Precautions should also be used in the removal of offensive products from one part of the premises to another. Difficulties in this respect now and then arise in works from insufficient space or bad arrangements of workshops and receptacles. In such cases as these, modifications may be necessary in the works themselves.

5. Offensive materials and products of the business should either be stored in impervious vessels or in a close chamber ventilated, if necessary, in such a manner that the effluvia shall not become a nuisance.

6. Sometimes a careful selection of the materials of the manufacture, or some little modification of the manner of conducting a part of the process may be sufficient to obviate an effluvium nuisance wholly or partially. But where the evolution of offensive gases or vapours is not thus avoidable, they must be intercepted in their passage to the external air, and dealt with in such a manner as to destroy their offensive character. One method of interception consists in arrangements for drawing off in a continuous manner the air of the entire chamber or workshop in which the offensive effluvia are evolved; but mostly the interception is practicable without doing this. When drawn off or collected, they may, according to their nature, be dealt with in one of five ways: 1. They may be discharged into the atmosphere at such an elevation as that they shall be so diluted before reaching the ground as not to be then offensive. When this will not suffice other means must be used. 2. If the evolved matters be condensible by cold, they may be passed through an appropriate condensing apparatus. 3. If soluble in water they may be submitted to the action of water in an appropriate apparatus, or similarly to the action of any other liquid better calculated to absorb them. 4. Sometimes, in like manner, solid substances, with which the effluvia have chemical affinity may be used with advantage, either in powder or otherwise. 5. If the evolved matters be combustible, they may be burned by conducting them through a fire.

Their particular application requires caution.

These are the general principles on which such effluvia must be dealt with, but their application to particular trades must depend upon a variety of considerations, even for the same trades, and for the same kind of effluvia. In selecting the method to be used much will depend upon whether or not the collection of the matters in one or the other way would be a source of profit. Rules of universal application can rarely be laid down, for the reason that individual establishments often have peculiarities of working which must be taken into account, while some are wanting in conveniences possessed or obtainable by other establishments. Much caution then is needed, together with a good deal of practical acquaintance with the details of manufacturing processes, in prescribing the actual method which should be used in any particular establishment. Happily, for all parties, it is commonly found in practice to be as much to the interest of the manufacturers as of the public that the emanations from offensive processes should be thus arrested. The offensive matters so recklessly thrown away into the atmosphere are often found to be matters which, if collected, are of commercial value, and may either be sold to advantage or utilised upon the premises. And generally it may be said with truth,—truth established by the experience of others beside myself who have given attention to the subject—that the use of due means to prevent effluvium nuisances in industrial establishments of all kinds often turns out to be in a variety of ways direct or indirect, and often unforeseen, conducive to prosperity. This is a fact which those most largely engaged in many of the most offensive businesses now recognise more or less completely. It need scarcely be added that the recognition of this important truth is calculated to facilitate very greatly the action of sanitary authorities in dealing with this class of nuisances. In the course of my inquiries, I have invariably found manufacturers and others largely engaged in offensive trades—the men who have had the greatest amount of experience in them—not only ready to discuss with me the various means that had been suggested or that had occurred to them or to myself, as practicable means of preventing nuisance from their works, but really anxious and glad to do so. This readiness to converse upon the subject has not only tended to the public benefit and has removed many difficulties out of my path, but in addition has imparted to my inquiry a most agreeable feature.

Difficulties of local authorities.

V. Any observations I may find it desirable to make in respect of the difficulties experienced by local authorities in dealing with this class of nuisances I propose reserving until the completion of the Report.

PART I.

Part I.
Effluvium Nuisances connected with the Keeping of Animals.

On EFFLUVIUM NUISANCES arising in connexion with BRANCHES OF INDUSTRY INVOLVING THE KEEPING OF ANIMALS.

The keeping of animals may cause nuisance injurious to health.

The Public Health Act, 1875, and the Nuisances Removal Act, 1855, (in force within the metropolis) both recognise the fact that animals may be so kept as to be a nuisance injurious to health. The rearing and keeping of animals for the sake of their produce, for sale, for slaughter as food, or for the sake of their labour, constitute a large part of the industry of the country. Sometimes this rearing and keeping of animals is the ostensible and main occupation of an individual, sometimes it is an occupation incidental to his ostensible and main business, sometimes it is supplementary only to it, the animals being reared and kept for pleasure or for the sake of some minor profit to be derived therefrom. A single animal may be so kept as to give rise to effluvium nuisance, but for the most part animals kept for profit are kept in larger number.

This part of my Report will deal only with the keeping of animals in confinement more or less complete. Such keeping of animals gives rise to nuisance chiefly where human population is aggregated, and the nuisance is more likely to arise, and when it arises to be more serious in character, where the population is dense than where it is sparse. But it is not solely amid aggregations of population that such nuisances may be occasioned. A single animal, badly kept, in or near a solitary house, may be a source of injury to the inhabitants of that house in consequence of the effluvia proceeding from it. Confining myself however to what is observable in London and large or small towns, and sometimes in villages, I may enumerate horsekeeping, cow-keeping, and pig-keeping as branches of industry which appear to fall so completely within the scope of this inquiry as to require to be dealt with more or less *in extenso*. For the most part the same principles as will be enunciated with respect to horses, cows, and pigs, both as they relate to the general character of the nuisances occasioned and as to the remedies to be applied, are applicable to dogs, goats, rabbits, poultry, pigeons, &c.

Horsekeeping.

Horsekeeping.

Varying modes in which horses are kept.

A person making it a business to visit stables where horses or asses are kept, as I have done, may observe every grade and variety of mode of lodgment, and of relationship between the lodging of the animals and that of the human beings living about them, from the stables in which the pleasure horses of the rich man are lodged as luxuriously (in their way) as their masters, to the miserable shanty in which the costermonger lodges his pony or donkey. Valuable horses get their share of the personal comforts with which their owners surround themselves ; and the decencies of the mansion are reproduced in the stable. On the other hand, the poor man's animal shares his owner's poverty, and cannot be expected to live more luxuriously than he does, or to be provided with appliances for decency and comfort which his master has never learned to feel necessary for himself or his family. But between the scrupulously clean, well paved, well drained, duly ventilated stable, with its polished stalls and neat iron or brass fittings, where the horses are carefully bedded on clean straw, and where manure is removed at short intervals, and the wooden, scarcely weather-proof, lean-to in the little back yard of a poor man's cottage, where there is absolutely no provision for drainage, where the manure and dirty litter are trodden down day after day, and only removed at long intervals, and then only to be accumulated in a heap in some spare corner, there is to be seen every conceivable variety of lodgment. And generally it may be said that the nuisances arising from horsekeeping are less or greater, according as the conditions of the mode of keeping assimilate to the one or the other of these two types. In a close court, more or less densely populated, where several stables approaching the latter type are situated, the nuisance is perhaps at its highest, especially in the summer time. Such courts or narrow spaces between the rears of neighbouring rows of cottages may be met with in London and large towns, and in them a casual visitor is at once struck with the all-pervading and persistent ammoniacal odour which the wind will sometimes carry, not only into the houses of the poor people who reside in the court itself, but also into better houses beyond it. London "mews,"[*] such as are to be seen at the rear of

"Mews."

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[*] The stables in mews are by no means always in the occupation of the person who occupies the dwelling-houses to which they severally belong, but are commonly let out to other persons, such as cab owners or tradesmen, and the dwelling rooms above are often again sublet to other persons.

On Effluvium-Nuisances, by Dr. Ballard.

many of the best streets at the west end or in the suburbs of London, are, as respects effluvium nuisances, often little better than such courts as I have just described. In these mews it is customary to see one or more rooms† constructed above the stable, which rooms are either inhabited by the groom or horsekeeper and his family, or let out to other families for residence. Whatever effluvia arise from the stable find their way into the residential parts above. Their passage upwards is in some instances facilitated by the staircase leading to the rooms proceeding directly from the interior of the stables. But even when this is not so, and where there is a separate entrance from the mews to the foot of the staircase, the pervading stable odour still penetrates to the rooms above, either through cracks in the ceiling or imperfections of the brickwork or woodwork of the structure itself.‡ The internal construction of the stables in a mews, and the appliances for wholesomeness, vary considerably. Some such stables are carefully kept, well paved, and fairly drained, while others may be not only filthy, but paved in such a manner that urine stagnates upon the surface, while the drain inlet, through which it should be carried away, is choked up with dung and filth; and yet human beings will be content to reside in the upper rooms. In some mews there are one or more dung pits provided for the use of the occupants, in others the dung pit is dispensed with, and each occupant lays his manure in a heap upon the surface of the mews outside the door of his stable, and here it remains until removed by a purchaser or contractor. It is not customary to store the dung in the stable itself.§ I have often found that no privy accommodation has been provided for the inhabitants of mews tenements: in such cases the excrement of the family is thrown upon the manure heap, or into the common dung pit. Sometimes I have seen a rough privy seat erected over one end of the dung pit, which thus becomes the privy pit also, and one open, moreover, to any passer-by who might choose to make use of it.

Sources of effluvium nuisances.

The effluvium nuisances of horsekeeping proceed mainly from, 1, fermenting filth, solid or liquid, within the stable itself, due to neglect of proper cleansing, to the protracted use of dirty and sodden litter, and to the soaking of urine and excremental matters into the floor, the result of its bad construction or of deficient provision for drainage; 2, the exhalations from the animals' lungs, skin, &c., and in some instances, perhaps, from diseased surfaces; 3, the too prolonged retention of manure in dung pits or dung heaps, and its consequent fermentation; 4, the disturbance of the fermenting dung for removal, and its cartage through public thoroughfares. The presence of a large number of horses in a very populous and crowded neighbourhood adds to the atmospheric pollution produced by the human crowding, and to the resultant deterioration of health. Old stables are often riddled beneath with rat runs, and where these communicate with adjoining houses they may introduce a concentrated effluvium into them from the stables. This is most likely to occur where the flooring is bad, and the drains are of brick, or other loose or soft material.

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† There are no back rooms to these mews-residences. The windows of the rooms open upon the roadway alone, so that there are no means of horizontal or through ventilation.

‡ Unwholesome dwellings of this kind can be dealt with by Sanitary Authorities as houses "Unfit for human habitation." The erection of such unwholesome residences can be prevented under such building byelaws as Sanitary Authorities are enabled to make, but not in the metropolis, since the 29th section of the Metropolis Buildings Act (the only clause apparently applicable) does not apply to residences arranged as mews-residences are arranged, that is, without back rooms.

§ As a curious instance of horsekeeping, I may mention what fell within my own experience when a medical officer of health in Islington. I was making an inspection of bakehouses, and in one case I had to pass from a sort of scullery, through a low, dark stable, close to the horse's heels, into the bakehouse, which had no other mode of access. A large number of recently-baked loaves were laid on shelves erected against the wall of the portion used as a stable, and within 3 feet of the horse's tail. On my calling the baker's attention to this, and suggesting that his customers would scarcely prefer bread thus stored before delivery, he explained that he did not send this to his ordinary customers—it was "contract bread."

Cow-keeping.

Cow-keeping.

Trade of a dairyman.

Cows are not now generally kept in confinement in towns unless they are large towns. The milk supply is usually derived from some outside country place. But in London and Edinburgh, cowkeeping for the supply of milk to the population, is an institution of long standing. To a less extent it is practised in such towns as Birmingham, and in some smaller towns, but mostly these establishments are, in such towns, situated in the suburbs. Breeding of calves is not practised in London cowsheds; cows are purchased in milk, and when they cease to give milk, are fattened and sold to the butcher. They are similarly sold to the butcher when they fall ill of any disease likely to terminate fatally, as soon as their milk is observed to fail. Cowhouses kept for dairy purposes are often located in narrow streets, in any small space which may happen to be available, and very commonly in the midst of crowded populations of poor people. The dairymen who keep them are often, under such circumstances, men of very small capital, and are satisfied if their cows are so lodged and fed as to give a due quantity of milk, without troubling themselves about the nuisance which results from their improper management or the damage they inflict upon the health of their neighbours or even of their own families. On the other hand I have seen in London most unexceptionable cowsheds, well arranged and well managed, and neither a nuisance nor likely to become so. For the most part, cowsheds in London are much too small for the number of cows crowded into them. Sometimes a dairyman's cowshed is nothing more than some disused stable, or a wooden dilapidated shanty without proper means provided for drainage or the maintenance of due cleanliness. The part of the shed on which the cows stand is usually raised an inch or two, and this raised part extends from the feeding trough as far back as the ordinary length of the cows, so that their hind feet stand at only a short distance from the edge. Beyond this, and at a lower level is usually a passage running the length of the shed. Sometimes a gutter is provided, between the passage and the cows standing place, for the droppings and urine to fall into, and in the course of this gutter are one or more gully openings leading to the drain. The part on which the cows stand and lie is usually not paved, except for a space of a few feet from the edge, since cowkeepers state that a hard paved surface injures the cows' knees when they lie down. The passage is usually paved in some way. The paving in London cowsheds is usually of ordinary bricks placed on edge. The channel may be of the same, but it is sometimes made of small slabs of stone and sometimes of wood.

Cowhouses; their ordinary arrangements.

Standing places.

The standing places of the cows are usually divided by low wooden partitions into stalls, and two cows are placed in each stall. The width of the stalls is just sufficient to allow the cows to lie down, *i.e.*, for single stalls about 4 feet, and for double stalls, not above 7 feet 6 inches. It is said that if more space is allowed the cows are likely to strangle themselves with their halters.

Feeding troughs food, &c.

The feeding trough is usually of wood or of brick covered with cement. Cows, thus kept, are fed mostly upon hay, mangolds, or turnips and brewer's grains. Some London cows also get a larger or smaller supply of distillers wash. Grains and wash are believed to stimulate the secretion of milk. Most London cowkeepers keep their cows very warm. The sheds are generally badly lighted and badly ventilated, so that the prevailing atmosphere is very warm and moist. The dung is swept up two or three times a day and is stored in a dung-pit sometimes outside the shed, sometimes within it. The dung-pit is usually made large enough to hold several days' accumulation, so as to avoid the inconvenience of frequent removal. In these pits, which are mostly of brick, but sometimes of wood, the dung ferments and sometimes becomes exceedingly offensive before it is removed. I have seen instances in which the cowshed is directly entered from the dairy or from the kitchen or one of the dwelling-rooms of the house.

Dung.

I have known establishments varying in the number of cows from 400 to two or three cows. The cubical space allotted to each cow in the sheds has varied within my experience from over 1,000 feet to a little over 200. The largest establishments, as a rule, are those which are best ventilated and which are least crowded. The most unwholesome sheds in London, as a rule, are those which were constructed or in use prior to the time when the licensing system was introduced; sheds erected since that time are vastly superior in every respect.

Capacity of sheds.

The principal effluvium nuisances arising from cowkeeping are dependent upon the filthy mode in which the cows are kept, the storing and removal of the manure, and the storing of the grains on which they are fed. The grains are commonly stored in a grains bin into which they are firmly trodden down. In the process of treading, the liquid matters are pressed out, and when proper provisions are not made for its flowing away into the drains, it stagnates on the surface of the yard and undergoing acetous fermentation emits an odour perceptible at a distance of many yards, and rendering habitations in the neighbourhood scarcely tolerable. Sometimes this precaution of treading down the grains is more or less neglected, and the whole mass of grains acetifies and becomes offensive. When the bin is of wood, the material itself becomes saturated with the liquid, and the bin is a source of great nuisance. Further, as in the case with horses, the presence of a number of cows upon a limited area in a close locality already crowded with habitations, adds materially to the general pollution of atmosphere which such human crowding occasions.

Sources of effluvium nuisances.

Pig-keeping.

Pig-keeping.

It is not necessary to say much in demonstration of the nuisance arising from the keeping of swine. The reports made by health officers in all parts of the country abound in illustration of it. It is a nuisance notorious in every town, and nearly every village in the kingdom. Nor can it be said that large establishments are on the whole less objectionable on this score than the two or three pigs commonly kept by poor men in the rear of their cottages. The fault appears to be that the pig has a bad name as an unclean animal whose habits are essentially and naturally filthy, and who will feast on disgusting food from which other animals of better repute will turn away. He is thus left to revel in the filth that he is supposed to prefer, and no pains are taken, for the most part, to teach him something better. To this popular prejudice I demur. A similar prejudice sometimes excuses neglect in providing sanitary appliances in the case of certain classes of the human population of the country. For I have heard the question asked, What is the good of providing wholesome lodging and appliances for drainage for people

Ordinarily a nuisance.

The pig is not naturally an unclean animal, whose habits are naturally filthy and indecent? The pig is not naturally an unclean animal; on the contrary, it is naturally a clean animal. When the pig wallows in mire he merely follows an instinct implanted in him, in common with some other pachydermatous creatures, the object of which is cutaneous cleansing. The mud stands to him in the relation of soap to a human being, but instead of washing it off with water he allows it to cake and dry upon his skin, and then rubs it all off, mud and cutaneous débris together, upon some sufficiently rough surface. Loose hair and cutaneous scurf irritate him and he takes his own way of cleansing his skin from them. Cleanse his skin for him and he will rest in contentment, without offending the eyes of his supercilious betters, often less scrupulous in this matter than he is, by his wallowings, scratchings, and scrubbings. It has long been known that a pig thus cleaned with soap and water not only becomes less objectionable but grows fat more speedily than if left to clean himself in his own way. Similarly as respects his food. A pig does not naturally prefer disgusting food. If left to pick up his living where he can find it, he will eat anything he can find that is eatable, but even then will eat acorns, fallen fruit, or roots in preference to garbage: and human beings in similar straits will act precisely in the same way. I am credibly informed that, even in London, there are men who regularly resort to the dung heaps adjoining certain London slaughter-houses and pick out from them, for conversion into human food, the unborn calves thrown there with other garbage by the butchers. It is not to be supposed that such wretched people would not prefer better food if they could get it. Garbage is not the food that the pig selects by preference. In fact a pig which has been fed for any time upon sweet food will turn away from sour and disgusting food. I have it on the authority of dealers with whom I once had to do at Belle Isle, near the Metropolitan Cattle Market, who used, at the time I speak of, to feed the pigs they had purchased for re-sale on blood and garbage from the abattoirs, that often pigs would nearly starve before they would touch the food set before them, only eating it under the pressure of acute hunger. I am not saying that it is not economical, or perhaps even a desirable thing, to convert into pork matters which can in no other way or in no way more convenient be made subservient to the subsistence of mankind, or that the pig is not properly utilised in this manner. I only wish to vindicate his character as a cleanly feeder, if only he has the chance of cleanly feeding vouchsafed him.

in person,

or food.

Still, as a matter of fact and daily observation, pigs are habitually kept even in the middle of populous towns in a most uncleanly and unwholesome manner, and the outcry against their being so kept is natural and not to be wondered at. Health officers, judging from their reports, would cut the knot of the difficulty by altogether forbidding the keeping of swine within the precincts of towns, or within some defined distance of inhabited dwellings.

Sources of effluvium nuisances.

The offensive odour from ill-kept and ill-managed piggeries will travel with the wind very considerable distances. The nuisance has its source, (1) in the filthy condition of the piggeries themselves, the accumulation of manure about them and its removal, often in a fermenting condition, and (2) in the storage and subsequent preparation of the food. The first source of nuisance is dependent partly upon the manner of construction of the sties, which are often mainly or entirely of wood, a material which absorbs offensive liquids and becomes saturated with them in course of time; partly upon the bad construction of the floor of the sties, often again partially or wholly of wood or imperfectly laid with bricks, or sometimes consisting merely of the bare earth; partly upon imperfect arrangements for drainage of the sties or the absence of any drainage at all, and partly upon neglect to cleanse the dung and filth from the sties at due intervals. As respects the second source of nuisance it is to be remarked that the feeding of pigs upon sweet food is the exception and not the rule of ordinary pig-keeping, the food that pigs ordinarily get is refuse food, tavern wash, or its congener town wash, consisting of scraps of food of all kinds, peelings of vegetables, rind of bacon, pot liquors of all sorts, &c., brewers grains, butchers offal, such as entrails, livers or blood, &c. The swill tub in most towns and villages is an institution wherever pigs are kept, and in many houses too where they are not kept, since its contents have a price; and throughout the year during hot as well as during cold weather the process of filling it goes on. Even when the tub is full, the wash or swill it contains is often not given at once to the pigs, but is kept in store for many weeks or even months, during which time it becomes most offensive from fermentation, while the top of the mixture acquires a layer of mouldiness. The swill is then unmitigated filth, yet is considered good enough for the food of pigs, and indeed their appropriate food. When in this condition, and when dipped out in this condition, the odour is insufferably offensive and sickening. At Calne, one of the most important bacon-curing towns in the kingdom, and where, consequently, nearly every cottager keeps pigs, potatoes, previously boiled, are heaped up in some corner of the back yard and kept there in a sour condition until they form a thick pasty uniform offensive mass, which is then dug out in portions from time to time as food for the pigs. When butchers keep pigs it is not unusual, especially in country towns and villages, to see the sty so arranged as to open upon the dung-pit, into which, together with the manure from the slaughter-house, are thrown blood and such entrails as cannot be used for human food. The pigs rummage in this filth and do a double duty there, eating the blood and garbage that they find and treading down the dung and litter. But sometimes these kinds of food are not given until they have been cooked by boiling, either alone or with meal or potatoes, diseased potatoes being commonly utilised in this way. This boiling of the food is often a still greater source of nuisance than the condition of filth of the sties, and the stench from it often spreads to distances which that from the sties does not reach.

The effluvium nuisances arising from the improper keeping of animals are injurious to health, upon general principles,

being nuisances having their origin in filth.

Such effluvium-nuisances as I have pointed out as arising from horse-keeping, cow-keeping, and pig-keeping are held by popular professional consent to be nuisances injurious to health; and inasmuch as they are effluvium nuisances due to *filth* in one form or another, the popular professional opinion is endorsed by scientific professional opinion. The late Medical Officer of the Board, Mr. Simon, writes in his second report to the Local Government Board: "Uncleanliness must, I "think, without doubt be reckoned as the deadliest of our present "removable causes of disease. In stating this opinion of its fatal influence, "I do not refer to it in its minor degrees, as compared with high standards "of cleanliness or chemical purity, but refer chiefly to such degrees of it "as fall, or ought to fall, within the designation of *Filth*:—to degrees, "namely, which in most cases obviously, and in other cases under but "slight mask, are such as any average man or woman should be disgusted "at: such as, eminently, the presence of putrescent refuse matter, solid "and fluid, causing nuisance by its effluvia and soakage. . . . It has "been among the oldest and most universal of medical experiences that

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" populations living amid Filth, and within direct reach of its polluting " influence, succumb to various diseases which under opposite conditions " are comparatively or absolutely unknown; and the broad knowledge " that Filth makes Disease is represented in the oldest records which exist " of legislation meant for masses of mankind. The exacter studies of " modern times have further shown that by various channels of indirect " and clandestine influence Filth can operate more subtly, and also far " more widely and more destructively than our forefathers conjectured." After alluding to the fatal influence of large doses of the offensive gases given off during organic decomposition, he goes on to say, " Far smaller " doses of these fœtid gases, as breathed with extreme dilution in " ordinary stinking atmospheres, both give immediate headache and " general discomfort to sensitive persons temporarily exposed to them, " and also appear to keep in a somewhat vaguely depressed state of " health many who habitually breathe them; but here, so far as we yet " know is the end of the potency of those stinking gases. . . . The " other and far wider possibilities of mischief which we recognize in Filth " are such as apparently must be attributed to *morbific ferments* or " *contagia;* matters which not only are not gaseous, but on the contrary, " so far as we know them, seem to have their essence, or an inseparable " part of it, in certain solid elements which the microscope discovers in " them; in living organisms, namely, which in their largest sizes are but " very minute microscopical objects, and at their least sizes are probably " unseen even with the microscope; organisms which, in virtue of their " vitality, are indefinitely self multiplying within their respective spheres " of operation, and which therefore, as in contrast with common poisons, " can develop indefinitely large ulterior effects from first doses which are " indefinitely small. Of ferments thus characterised, the apparently " essential factors of specific chemical processes, at least one sort—the " ordinary septic ferment—seems always to be present when putrefactive " changes are in progress, as of course in all decaying animal refuse " while others, though certainly not essential to all such putridity, are in " different degrees apt, and some of them little less than certain, to be. " frequent incidents of our ordinary refuse. . . . It is by these " various agencies (essential and incidental) that Filth produces 'zymotic " disease.' . . . Ill ventilated, low-lying localities, if unclean as " regards the removal of their refuse, may especially be expected to " have these ferments present in their common atmosphere, as well as of " course teeming in their soil and ground-water." The main truth thus admirably formulated by Mr. Simon is axiomatic. It is the result of extended experience and protracted observation, and being an axiom, may duly and logically used in reasoning by way of deduction.[*] Not only may axioms be thus used, but they ought to be thus used for the benefit of mankind. The practical application of the axiom that 'Filth produçes disease' to the particular case of the filthy keeping of animals is self evident. But in order to make the application clearer, I may again refer to Mr. Simon's report and quote some further remarks of his upon the general subject of filth-produced disease. After referring to the fact that excess of disease in filthy places is not always due only to the filth, he goes on to point out that notwithstanding mixed cases, "in filthy urban districts " where the foul air, comparatively incarcerated in courts and alleys and " narrow streets, can act with most force in regard to masses of population, the population always shows an increased mortality under " several titles of disease. Such miscellaneous increase of mortality

This is an axiom.

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[*] " Axioms duly and methodically drawn from particulars will again easily point " out new particulars and so render the sciences active."—*Novum Organum.*

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“ affects probably all ages, more or less, but a distinctively large proportion of it attaches to the children. Apparently the mere influences “ of the Filth (apart from other influences) in such a district will be “ causing the infants and young children to die at twice or thrice or “ four times their fair standard rate of mortality. . . . In trying to “ analyse the death-statistics of filthy districts we soon find that, with “ regard to many of the separate elements in the miscellaneous “ mortality, we cannot argue in exact scientific terms: partly because very “ large quantities are registered under names which have no definite “ nosological meaning—*e.g.*, ‘convulsions,’ ‘teething,’ ‘atrophy,’ ‘consumption;’ partly also because some kinds which we can fairly “ identify by name (*e.g.*, pneumonia)* are such as we do not always “ ætiologically understand; and sometimes we may be only able to establish the broad fact that, within the area of Filth, the deaths in total “ amount are greatly more numerous than they ought to be, and that the “ excess (or in mixed cases a certain share of excess) can only be accounted for as the effect of the Filth.” Nevertheless, both experiment and professional experience combine (as he proceeds to point out) to show that septic ferment, however it may enter the blood, is apt to find the way thence to the bowels, so that diarrhœal affections become the most prominent of the diseases distinctively due to filth. Moreover, “experimentally we know of this ferment, that, when it is enabled by artificial inoculations to act in its most effective way on the animal body, and even more when it has received a curious increment of strength which its first propagation within the living body seems to bestow on it, it shows itself one of the most tremendous of zymotic poisons;” that it develops “disease exactly corresponding to certain very “ fatal and, unfortunately, not infrequent infections to which lying-in “ women, and persons with accidental wounds and the wounds of surgical “ operations, are most subject, but which also occur independently of “ such exceptional states; infections chiefly known under the names of “ erysipelas, pyæmia, septicæmia, and puerperal fever; infections which “ we sometimes see locally arising anew in unquestionable dependence “ on Filth, but of some of which, when arisen, it is perfectly well known “ that they are among the most communicable of diseases. And a further, “ perhaps still more instructive, teaching of the artificial infections is this: “ that the ‘common’ ferment, which in its stronger actions quickly destroys “ life by septicæmia, can in slighter actions start in the infected body “ chronic processes which will eventuate in general tubercular disease.” After making all necessary reserves in the application of these results of experiment to the condition of ordinary life, he goes on to say that, “looking well at the pathology of human life, under residence in “ *foul air*, we find ourselves again and again reminded of these results of “ physiological experiment; often seeing phthisis and other tubercular and “ like diseases gradually developed, as though under gradual overpowering “ of the limited normal resistance to the septic ferment; or seeing—and “ particularly where some exceptional bodily state (wounded or puerperal) “ gives opportunity, the sudden invasion of erysipelas or other septic “ infection, not in discoverable dependence on any human infectant, but “ conceivably a filth-inoculation from the air.”

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* On the relation of certain cases of pneumonia to filth, an interesting and instructive paper on “Pythogenic Pneumonia,” by Dr. T. W. Grimshaw, in the “Dublin “ Journal of Medical Science” for May 1875, may be consulted with advantage. See also some further observations of my own as to epizootic pleuro-pneumonia, quoted later in this Report. I may add that during a long service as a dispensary physician in London, I was myself forcibly impressed by the preferential frequency of a fatal form of pneumonia, especially among children, in the filthy ill-drained courts of the metropolis.—E. B.

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No illustrations or proofs are necessary in the application of the doctrine thus propounded by Mr. Simon; it is sufficient to say that the universal experience of medical men affirms the fact that diseases, especially those forms of diseases and kinds of death referred to by Mr. Simon, are exceptionally frequent in filthy mews among residents over stables, and where cows and pigs as well as other animals are kept in a filthy or unclean condition, and where the effluvia from such keeping are concentrated within a confined space by peculiarities of locality.*

Illustrations derived from experience.

Nevertheless I cannot refrain from making the following extract from Dr. Buchanan's annual report for 1862 to the Board of Works of St. Giles' district, where he was at that time Medical Officer of Health:—

Dr. Buchanan's observations.

" The main point that appeared needful to be established in evidence " before the magistrates was, that injury was inflicted on the health of " the neighbourhood by the presence of cowsheds in St. Giles'. To " those who had been engaged in observing the sanitary state of the " people through a series of years, this did not appear at all doubtful; " but it seemed desirable to get, if possible, some numerical proof of " such injury to health. With this view, the sanitary statistics of nearly " six years were examined with reference to one particular cowhouse, " that in Stacey Street, which was so situated that its influence on " health could be measured. The end of Stacey Street, at which the " cowhouse is situate, would be expected, *primâ facie*, to have sani- " tary advantages over the other end, which abuts on the middle of " Dudley Street, a neighbourhood which the readers of this report well " know to be unhealthy beyond most other parts of the parish of St. " Giles'. Now, on an analysis of the mortality, it was found that, three " houses excepted, there had been an average of three deaths in each " inhabited house, and in none a higher mortality than six in the six " years. But in the three houses, Nos. 6, 7, and 9 there had been an " average of 10 deaths each; viz., in No. 6, seven deaths; in No. 9, " nine deaths; and in No. 7, actually 14 deaths in the period under " examination. Now No. 7 is the house most directly connected with " the cowsheds; Nos. 6 and 9 are the two houses flanking it. No. 8 " consists only of workshops and the entrance to the cow-yard. In " these three houses, Nos. 6, 7, and 9, 30 deaths occurred, while the

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* Confirmatory evidence of the injuriousness of these filthy effluvia from ill-kept animals may be derived from considering the effect they have upon the animals themselves. I may illustrate this effect by some observations of my own, made on two separate occasions, on one of which pleuro-pneumonia was prevalent in the London cowsheds, and on another when the cattle plague was present in this country. On both of these occasions I took the trouble to compare the prevalence of the disease in the cowsheds in Islington with that of the practice of storing the dung of the animals within the cowshed itself. In the case of the lung disease, I found that in 1857, while 8 out of 31 sheds in which the manure was not stored within the shed had had cases of lung disease, as many as 8 out of 11 in which the dung was stored within the shed had had cases of it. And as respects cattle plague in 1865, I found, generally, that, while 66 per cent. of the sheds in which the manure was not stored within the shed were invaded by the disease, as many as 91 per cent. of those in which it was so stored were invaded; and that the influence of this filthy practice in promoting attack was most obvious in the smallest establishments, which were less liable than the larger ones to the introduction of the contagion; since, while but 53 per cent. of the sheds of the first class were invaded, none at all of this second class escaped invasion. It is in these small establishments that the dung is habitually kept for the longest period of time before removal. The bearing of these facts upon the supply of wholesome meat in towns is obvious. [For a fuller statement of these observations, see Appendix E. to the Second Report of the Cattle Plague Commission, 1866.]

Drs. Druitt and Aldis also mention in one of their Reports the occurrence and spread of "influenza," accompanied by "sore throat," among horses in an ill-kept stable in their district, and that the disease was attributed by the veterinary surgeon in attendance to the unwholesome state of the stable.

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" other 14 inhabited houses had only 40 deaths between them. The only two fever deaths in the street were in these houses abutting on the cow-yard. Three out of the five deaths from diarrhœa were in them. Out of 10 deaths from acute lung disease which follow (as has been often shown) the zymotic deaths in their distribution, and depend upon similar impurity of air, eight occurred in these three houses. The Stacey Street cowhouse was the only one in which a numerical estimate was attempted of the influence on the health of the neighbourhood. But on the strength of the facts where ascertained, the reply was not difficult to the question of the counsel who had been retained in the interest of these nuisances: 'Do you mean to say that a cowhouse and yard is more detrimental to the health of a neighbourhood than if the same space were covered with poor houses?'—'Yes, it positively is so.'"

Another extract from Dr. Buchanan's report for 1860, relating to mews may not be out of place. It relates to a place called Southampton Mews, in respect of which proceedings (much delayed) were pending: "Meanwhile, in the summer of 1859, the houses of Bloomsbury Place and Bloomsbury Square, on which these premises in the mews abut, were pervaded by bad smells and by zymotic diseases, referred by the medical attendants of the cases to the miasms of the mews. In the summer of 1860, again the same smells, and again the same outbreak in the neighbouring houses, this time taking the form of diphtheritis. In November, a child from the house itself died of diphtheritis in University College Hospital. And now, in the summer of 1861, among other complaints, a medical practitioner writes from Bloomsbury Square: 'As usual, now that the abominations of Southampton Mews are upon us, and the smell has been most unpleasant, diphtheria has broken out at No. 25 in this square, also at No. 27.'"

Drs. Druitt and Aldis' observations.

In Drs. Druitt and Aldis' annual reports upon the sanitary condition of St. George's, Hanover Square, I find among other illustrations of the injury to health occasioned by mews-stables, the following reference to diphtheria, which, taken in connexion with what has just preceded, and with some observations made in New York, to be referred to presently, is at least very suggestive. In their report for 1868 they mention that in the month of January diphtheria occurred "in one of the stables in Kinnerton Street, where six children, whose ages varied between five and fifteen, were attacked with the disease, three of whom died. The disease appeared in other stables and houses in the same locality, and some of the patients were taken to St. George's Hospital. . . The stable was offensive." They further mention the fact that in the fourth quarter of 1858 only three cases of diphtheria occurred in the public medical practice of which they received records. Such cases occurred in a different mews.

Observations made in New York.

In connexion with this last quotation I may quote the following passages from the "Report of the Council of Hygiene and Public Health of the Citizens' Association of New York upon the sanitary condition of the City" (1865). In respect of the third district, Dr. Hampton Harriott writes: "In regard to the influence of stables upon the public health, I think that I have, in many cases, traced to their influence (especially when occupied by sick and disabled horses) an earlier invasion and increased prevalence of such diseases as scarlatina and diphtheria." In respect of the same district, Dr. Keeney writes: "That they produce a deleterious effect upon the health of their immediate localities, I infer from the marked and fatal prevalence of certain peculiar diseases in their immediate and most exposed vicinity. Cholera infantum is one of the maladies here referred to." In respect

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of the fourth district, Dr. Ezra Pulling writes: "The noxious gases arising from these places contribute in no small degree towards vitiating the atmosphere of the crowded tenements by which they are usually surrounded. A reference to the large map accompanying this report will show that many of the localities where the existence of typhus or typhoid fever is indicated are in the immediate vicinity of stables, the emanations from which appear to be predisposing, if not exciting, causes of several forms of zymotic disease. Of 44 cases of erysipelas occurring during the past year, no less than 31 were adjacent to or within 25 feet of stables. At No. 10 —— Street, which is contiguous to one of the largest stables in this district, four cases of this affection occurred. The rear of No. 27 —— Street adjoins a stable, and is within 25 feet of another. In this house, which is occupied by five families, there were three cases of erysipelas. The rear of No. 22, Cherry Street, which contains 16 families, is separated from a large stable by a vacant lot, into which runs much of the fluid part of the manure. In this house five cases of the above disease were reported during the year. Zymotic affections of the throat and lungs appear to be very prevalent in those localities where the litter of stables is undergoing fermentation. One of my colleagues has already stated to the Council his belief that gaseous emanations from these sources are conducive to the spread of diphtheria; and while my own observations tend to confirm his theory, I believe it to be equally true of an insidious and very fatal form of pneumonia. . . . Indeed, it may be said that zymotic diseases of all kinds appear to be exceedingly rife in this region." In respect of the 15th district, Dr. James Ross writes: "At No. —— Avenue B, a horse stable occupies the rear area of the lot, and the entrance to the stables is made only through the door and hall of the tenant-house. I found two of the scrofulous children in that house on crutches. The grave has strong claim upon others. . . . The prevalence and fatality of pulmonary disease among horses in overcrowded and neglected stables is only equalled by the fatality of like maladies in the women and children of tenant-houses." In respect of the 16th district, Dr. W. C. Hunter writes: "The principal insalubrious feature of these stables is their effect upon rear buildings. This happens when a stable in the rear joins a rear dwelling next door. . . . A stable is placed in the rear of one street, and on the opposite street is a rear dwelling-house. The rear walls of the two buildings are within 2 or 4 feet of each other (this intervening space being an unwholesome 'cloaque'), with a small rear bedroom window of the dwelling, and a breathing hole for the animal in the stable; both window and opening being on the same plane. This is precisely what is seen at No. 278, West Seventeenth Street, where the bedroom window must be kept constantly closed to prevent the unpleasant odour from the stables entering the apartment. Three cases of purulent ophthalmia have occurred here, and typhus prevails in the front house."

Mode of preventing nuisances.

As to the mode of preventing or minimizing the effluvium nuisances from horse-keeping, cow-keeping, and pig-keeping:—

From Horse-keeping.

From Horse-keeping.

The prime essentials of the wholesome stabling of horses are cleanliness and the due removal of manure.

Proper flooring of stables.

1. The flooring of the stable should be of such materials and so laid as to permit the ready flowing away of liquid manure from the standing of the animal. For this purpose the flooring should be as even and

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uniform as possible, and such as is incapable of absorbing urine or other liquids that may fall upon it. Hence, the best flooring theoretically, is one which is jointless, firm, and properly sloped to a proper channel. The worst sort of paving that I have seen in ordinary use is that made with round pebbles laid upon the unprepared ground. Brick is too absorbent to make a good pavement, square stones sets, and what are termed iron-stone bricks laid upon a duly prepared foundation of concrete are better. But even these are not equal as a flooring to a hard cement. The most perfect flooring that I have seen has been in stables laid with the patent cement of Wilkinson & Co., of Newcastle. It bears very rough wear admirably. It is a cement made with Portland cement and roughly ground stone or granite chippings run upon a basis of brickbats. [See a fuller description below under the head of "Slaughtering of Horned Cattle," &c.]

Drainage.

2. There should be provision for proper drainage. The channel leading to the drain inlet should be impervious and even like the flooring or gully. The drains should be of stoneware pipes, which resist the ravages of rats. The drain inlet should be outside the stable and provided with an appropriate trapping arrangement.

Litter, &c.

3. The dung should be removed from the floor of the stable at short intervals. Straw or other litter used for the bed of the animal should not be used a second time after being saturated with the urine.

Storage of manure.

4. Manure should not be permitted to accumulate in the place provided for its reception, if that place be near enough to inhabited houses to become a source of nuisance from its effluvia.

When horse manure is necessarily retained on premises for several days (an event which only ought to happen accidentally), it ought to be so stored as not to be liable to undergo compression, the atmosphere should have the freest access to all parts of the deposit, and provision should be made for the draining of all liquid matters from it into an appropriate drain. It has been said that sprinkling the manure freely with dilute sulphuric acid (a cheap agent) assists in preventing the rise of effluvia, but I have had no experience of this expedient.

Cleanliness.

5. The flooring of stables should be daily washed down with water, and the walls and ceiling periodically lime-whited, and always kept clean.

"Mews."

There ought never to be any difficulty in providing, so far as this, against effluvium nuisances arising from horse-keeping. Difficulty begins to appear when the question of residences over stables, as in London mews, arises. It is to my mind doubtful whether the best devised scheme for rendering such residences wholesome would be altogether successful. The principle, however, to go upon in making an endeavour to render them wholesome is, in addition to what has been above suggested, to dissociate by the best known means the atmosphere of the stable below from that of the dwelling-place above, and to provide for the separate horizontal ventilation of the stables and of the dwelling rooms. To carry out the first of these objects it would be necessary to construct the walls of a material which shall be non-absorbent and practically impermeable by stable vapours and gases; and either to construct the ceiling with similar materials, or to interpose an impermeable material between the ceiling and the dwelling rooms above.* In addition to this, the staircase leading to the rooms above should be placed as far as possible from the stables, should open directly from the street, and its side walls should be constructed of similar impermeable material to that employed in the stable itself, and the staircase should have a distinct and separate ventilation from the roof.

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* I am assured by the Architectural Department that there would be no practical difficulty in obtaining such atmospheric isolation, by the use of such materials as glazed bricks, well and closely set in cement, or by the use of good cement for the lining of the walls and flooring of the rooms above.

From Cow-keeping.

From Cow-keeping.

The essentials for wholesome cow-keeping and the avoidance of effluvium-nuisances where cows are kept in populous places relate, *a*, to the construction of the cowsheds ; *b*, to cleanliness and proper management of the manure ; *c*, to the proper storage of their food.

Proper construction of cowsheds &c.

a.—1. A cowshed should not be crowded. There should be ample space for the circulation of air both at the head and tail of the cows (an object which may be gained by means of a sufficiently wide passage at both ends of the stalls), and the total cubic capacity of the shed per cow, for cows of average size, should not be less than 1,000 cubic feet. 2. The paving should, as respects material, be similar to that recommended for stables. It should be non-absorbent. The best material is a firm, hard asphalte, or ironstone bricks set in cement, in any case laid upon at least 4 inches of good concrete, or it may be altogether constructed of good firm cement. In London, where usually no litter is provided for the cows to lie down upon, it is customary not to pave the floor towards the head of the stall, on account of the injury likely to be done to the knees of the cows in the act of lying down, but to put in that part a layer of earth, sand mixed with clay, fine brick rubbish, or other soft material. Where litter is used the stalls may be paved throughout. But litter of any kind is objectionable unless renewed daily. It becomes damp and sodden from the exhalations of the cows when they lie down, and is then said to be injurious to the health of the cows. 3. The walls of the shed should be of brick or stone, and faced to a height of at least 4 feet with a dado of good even cement, or with zinc, slate, or other non-absorbent material. 4. There should be good ventilation and lighting. Both lighting and ventilation are best effected from the roof. 5. The feeding trough at the head of the stalls should be constructed of iron or of some other non-absorbent material. 6. There should be a channel of non-absorbent material running along the tail end of the stalls. The pavement should be so sloped as to drain into it, and the channel itself should be of sufficient depth and width and be so sloped as to conduct away liquid matters readily. It should conduct such matters to a pipe drain inlet properly constructed outside the shed. 7. It is desirable that a cowshed should always be a detached building standing in its own yard, but where any part of a shed adjoins a dwelling-house a party wall of non-absorbent material should intervene. In no case should any room of a dwelling-house or any room used as a dairy communicate with a cowshed. 8. The dung should never be stored within the shed. When practicable, a dung-pit should be altogether dispensed with ; it never fails to be a source of nuisance to the neighbourhood. The proper plan to adopt would be to place dung at once in the receptacle or conveyance in which it will be conveyed away, and this should be constructed of iron or other non-absorbent material and kept clean.

Mode of dealing

Cleanly management of sheds.

b.—1. The manure should be swept up and carried to the receptacle at least every six hours, and in the intervals the channel should be kept sufficiently clear for liquid matters to run off, and twice a day the channel and passages should be cleansed with water, and the dado similarly cleansed at short intervals. For this purpose a proper water supply should be provided within the shed at such an elevation that the water can be delivered by a hose so as to reach all parts that it is necessary to wash. 2. The whole interior of the walls and ceiling should be regularly and periodically limewashed at due intervals. 3. The cows themselves should be kept clean by proper grooming. 4. The manure should be removed from the premises, in the covered receptacles provided, daily or at very short intervals, and the receptacles should be cleansed before their return to the yard. 5. The yard itself should be well paved, preferably in the manner recommended for the cowshed itself, be well drained and kept clean.

Proper storage of grains, &c.

c.—Grains or other kinds of food likely to become sour should be kept in non-absorbent receptacles outside the shed, and duly protected from the weather. Grains should be well pressed down, and the receptacle should be provided with due means for conducting away into the drain, without exposure to the air, any liquids which may ooze from them. This receptacle should always be thoroughly cleansed within with hot water from time to time of its being replenished. Apparently with a view to facilitate this, the St. Giles' Board of Works in the metropolis requires that there shall be two grain receptacles provided, or if there be only one that it shall be divided by a partition.

From Pig-keeping.

From Pig-keeping.

The most scrupulous care is requisite to prevent pig-keeping becoming a nuisance, when carried on near inhabited houses.

Proper construction of sties.

a.—In respect of the construction and arrangement of the sties. 1. They should in no case abut upon or communicate with any part of a dwelling-house. 2. When pigs are kept in any considerable number, a proper enclosed room or building of brick or stone should be provided for the purpose, and it should be lighted and ventilated, preferably from the roof. If the pigs be kept in low sties erected within a yard, the whole sty (*i.e.*, every part to which the pigs have access) should be covered with roofing in such a way as to effectually prevent the ingress of rain. 3. The flooring should be of some material impervious to wet: asphalte or cement, or good glazed bricks, closely laid in cement upon a basis of good concrete, are the best materials. It should be properly sloped to a channel running along the front of the sties and leading to a proper drain inlet outside the sties. 4. The walls of the sties should be constructed of impervious materials, such as stone, or slate slabs, or glazed bricks well set in cement, and the feeding trough should also be of some impervious material. No wood should on any account be permitted in any part of the sties. 5. The yard or building within which the sties are situated should be paved in a similar manner to the sties themselves, and be well drained.

Cleanly management.

b.—In respect of cleanliness. 1. The pigs should at all times be provided with an ample supply of clean litter. The best materials to use are clean straw or a layer of about 3 inches of sawdust. The litter should be renewed, and all manure removed from the sties, daily. 2. Prior to such fresh supply of litter the floor and walls of the sties should be thoroughly washed and cleansed daily. 3. The pigs themselves should also be cleansed and scrubbed at least once a week with soap and water. 4. The manure and foul litter should be removed from the premises daily.

Proper storage, &c. of food.

c.—In respect of the storage and preparation of the food. 1. No offensive or sour pig food should be kept or used on the premises. If grains are used they should be stored in the manner recommended for cow-keeping. 2. The preparation of food by boiling should be carried on in the manner recommended for tripe and trotter boiling.

Part II. Effluvium-Nuisances connected with the Slaughtering of Animals.

Part II.

On Effluvium-Nuisances arising in connexion with the Slaughtering of Animals.

In this division of my Report I propose confining myself to the slaughtering of horned cattle, sheep, pigs, and horses.

Slaughtering of Cattle, Sheep, and Pigs.

The Slaughtering of Horned Cattle, Sheep, and Pigs for Human Food.

Establishments visited.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Nov. 26, 1875	Corporation abattoir.	Manchester -	Blood albumen making, clot drying, blood manure making.
Jan. 19, 1876	Williams (Pigs) -	Bedminster -	Bacon curing.
„ 21 „	Skull (do.) -	Bristol - -	Do.
„ „ „	Dole (do.) -	Do. - -	Do.
May 22 „	Two large semi-public abattoirs.	Leeds - -	Separation (at one of them) of serum from blood.
June 9 „	Corporation abattoir.	Reading.	
July 27 „	Corporation slaughter-house.	Monmouth.	
Oct. — „	22 slaughter-houses	Aldgate, City of London.	
„ 26 „	Slaughter-houses at cattle market.	Deptford - -	Separation of serum from blood, gut scraping, boiling of flesh, &c.
Nov. 15 „	Corporation abattoir.	Croydon - -	Separation of serum from blood.
„ „ „	West and Hayr -	Do.	
„ 28 „	Corporation abattoir.	Hereford.	
„ 30 „	Do. -	Lancaster.	
Dec. 2 „	Moore Street abattoir.	Glasgow - -	Tripe boiling, boiling of condemned meat.
„ „ „	Victoria Street abattoir.	Do. - -	Separation of serum from blood.
„ „ „	Scott Street abattoir.	Do.	
„ 6 „	2 groups of slaughter-houses or semi-public abattoirs.	Newcastle-on-Tyne.	
Jan. 11, 1877	Government slaughter-house.	Portsmouth.	
	Several private slaughter-houses.	Do.	
„ 19 „	Corporation slaughter-houses.	Metropolitan Cattle Market.	
„ „ „	Whitlaw - -	Islington.	
„ 29 „	Day (Pigs) -	Reading (Cross Street).	Bacon curing, gut scraping, &c.
„ „ „	Day (do.) -	Reading (Munster Street).	Bacon curing
„ „ „	Thomson (do.) -	Reading - -	Do.

The Slaughtering of Horned Cattle, &c.—*continued.*

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Jan. 30 1877	Thomas Harris (Pigs).	Calne - -	Do., and associated processes.
" " "	C. Harris & Co. (Pigs).	Do. - -	Bacon curing, gut scraping, &c.
Mar. 22 "	Birkett - -	South Shields	
" " "	Gallan - -	Do.	
" " "	Tyson - -	Do.	
" " "	Postgate - -	Do.	
" " "	Cutch (Pigs) -	Do.	
" " "	Blakey - -	Do.	
" " "	Brown - -	Do.	
" " "	Swan - -	Do.	
" " "	Taylor - -	Do.	
" " "	Another, name unknown.	Do.	
At various times.	Many other establishments.	London and various towns.	

Places where it is carried on.

Slaughtering is usually conducted within a building specially adapted for the purpose; but occasionally this is not the case, and animals are slaughtered for food in an open yard, in some stable or inappropriate outhouse or even within a dwelling-house, in a room, cellar, or shop. On occasion of a visit I paid to South Shields, I observed that in that town it is the rule, to which there are very few exceptions, for the slaughtering, even of horned cattle, to be conducted in the open shop forming part of the butcher's dwelling-house. And this arrangement exists even in very small shops in the lowest, narrowest, and most unwholesome streets. I am informed, moreover, that the same practice is followed in other towns in that part of the country.

Private slaughter-houses.

Slaughter-houses may be private or public. Private slaughter-houses are commonly located on premises forming part of those occupied by retail or wholesale meat salesmen or butchers and their families, part of the premises being used as a shop for the sale of the meat killed. The position of the slaughter-house in such cases and the facilities of access to it depend upon the position and extent of free unoccupied space at the rear or at the side of the house and shop, and the relation of the premises to public or private roadways. For the most part the slaughter-house is situated at a distance of some yards from the house and shop, sometimes close to them and sometimes it communicates directly with one or both. When there is a public or private roadway from which the slaughter-house can be entered, the animals to be slaughtered are introduced thereby, but when no such convenience exists they may be driven to slaughter through the shop or even through the dwelling-house. The size of private slaughter-houses varies with the nature of the trade done and with its extent. In some instances when sheep or pigs only are killed the slaughter-house is small and low-pitched, but where horned cattle are killed the pitch is generally higher and the slaughter-house more or less capacious. It is not unusual in London, and in other places also, for a private slaughterman to permit other butchers to kill in his slaughter-house when he has completed his own slaughtering. But, as I have hinted above, private slaughterhouses are not always situated on the premises used by butchers as shop and residence. Sometimes they are on different (but not distant) premises altogether, and when this is so, the slaughter-houses are usually to be found in neighbourhoods occupied by poor people, often in narrow, close, ill-ventilated streets, courts, or mews, usually forming part of a row of buildings in such a place, and being entered directly from the roadway. They would not be tolerated in better neighbourhoods.

Public slaughter-houses.

Public slaughter-houses ("abattoirs") are to be met with in a few of our larger towns. In some such towns private slaughter-houses have been almost or altogether done away with. Of those I have seen, the abattoir at the Foreign Cattle Market at Deptford, and the abattoirs at Croydon, Manchester, Reading, Hereford, and Glasgow are unobjectionable as to locality, being either situated at the outskirts of the towns or in places sufficiently isolated. Some, however, such as the abattoirs at Monmouth, Leeds, Newcastle-on-Tyne, and Lancaster are not so well situated; those at Newcastle and Lancaster, particularly, are situated in a closely built part of the respective towns. Mostly, public abattoirs are the property of the Sanitary Authority of the respective towns. This is the case at Croydon, Manchester, Reading, Hereford, Glasgow, Monmouth, and Lancaster, at which last-named place the abattoir is erected close to the dead meat market. At Newcastle there are two abattoirs the property of private companies. Those at Leeds belong to private owners, and I only rank them among public abattoirs because there is a community of slaughtering there. Those at Leeds might perhaps be better called semi-public. I scarcely know whether to class the slaughter-houses at the Metropolitan Cattle Market among the public or private slaughter-houses, for they are let out by the Corporation of the City to slaughtermen in a large way of business, who slaughter only for the supply of the dead meat market, and who only permit private butchers to slaughter there under conditions and restrictions of their own imposing. There is nothing objectionable on sanitary grounds in their position since they are far removed from inhabited buildings. At some of the public abattoirs I have mentioned a part of the building is appropriated for the use of any butcher who may wish to slaughter there, a charge being made for each animal slaughtered. Other parts are so arranged as to give a separate slaughtering place to individual butchers who pay a rent for the part of the premises they occupy. At some of the public slaughter-houses, even among those which are the property of the Sanitary Authority, the latter is the only arrangement in force. But in all cases where public abattoirs are the property of the Sanitary Authority the slaughtering is carried on under regulations imposed by the Authority.

The business of a slaughterman described.

The business of a slaughterman may be considered under the following heads, viz.: 1. The keeping the animals for the requisite time before slaughtering. 2. The actual process of slaughtering and "dressing" of the carcass. 3. The disposal of the offal, garbage, and blood.

1. Keeping of animals before slaughter,

"lairs" and "pounds."

1. As to the keeping of the animals prior to slaughter. Unless a butcher slaughters the animals he has purchased on the day of purchase, he must deposit them somewhere, and at that place they may require to be fed. A place used for this purpose is properly designated a "lair," and in such a place animals may be and are kept for several days. But, again, he must have on his premises and close to the slaughter-house, a place where animals which are intended for immediate slaughter may stand. Such a place is properly termed a "pound." Animals are sometimes kept in the "lairs" for several days, but they are only properly kept in the "pound" for a few hours. In the best public abattoirs, this distinction between the "lairs" and the "pound" is maintained, but in some there is no such distinction. In private slaughter-houses, also, either there is usually no such distinction made, the "pound" being used when necessary as a "lair" or the lair used is not upon the same premises as

the "pound." In some abattoirs, as at Lancaster, there is neither pound nor lair; unless an open space there, undivided in any way, between the abattoirs and the market be regarded as a lair, and a dirty corner at the end of the row of slaughter-houses can be regarded as a pound. In the best arranged slaughter-houses, both public and private, that I have seen, the pound is separated by a free space from the slaughter-houses. But in many, both public and private, even in some otherwise unexceptionable in general arrangements, the pound is actually within the slaughter-house, under the same roof, and virtually only a part of the slaughter-house area partially divided off by a rail or low partition of some kind, or it is a shed or small building communicating directly by a door-way with the slaughter-house. Still more objectionable arrangements are to be met with in the private slaughter-houses of some towns. In a Report made last year by Dr. Spear, the medical officer of health for South Shields, to the sanitary authority of that town, I find a tabulated statement showing among other things that in various (91) private butchering establishments there, the "pound" is located in the following kinds of places, viz. :—In 24 instances the shop itself was used for this purpose; in 14 instances a room of the dwelling-house; in 4 instances a cupboard within the dwelling-house; in 4 instances a cellar within the dwelling-houses, and in 4 a wash-house, sometimes adjoining inhabited rooms. Such places, I imagined, could only be used for sheep or pigs; but I found, on visiting the premises referred to, that even horned cattle are pounded thus unwholesomely in some instances. My experience of pounds in private slaughter-houses has given me a very unfavourable general impression of them. No doubt many that I have seen are well paved and kept clean, but mostly any filthy place appears to be regarded as good enough to put animals in prior to slaughtering them. In some small private establishments where the slaughter-house is situated in the back yard of the dwelling-house, I have seen sheep or pigs kept day after day in the unoccupied part of the yard, sometimes nearly filling it, and creating much annoyance to neighbours by their noise and the odour of their effluvia. I have seen in some pounds (even in London since the licensing period), a layer of trodden-in dung and litter, many inches thick, encrusted upon the floor, and the walls thickly begrimed with filth; while the slaughter-house itself has been clean and limewhited, this being the part of the premises which alone the inspector of nuisances was supposed to concern himself with. When the pound forms virtually part of the slaughter-house area, it is usually cleaned down when the slaughter-house itself is cleaned, but sometimes even under this arrangement I have seen it filthy and neglected. Where public abattoirs are under the control of the sanitary authority, the pound is usually kept in a wholesome condition in the same way as the slaughter-house itself.

2. Actual process of slaughtering,

2. The actual process of slaughtering. This differs in the case of horned cattle, sheep, and pigs.

of oxen,

a. In this country *oxen* are always (except when they are slaughtered in the Jewish fashion) pole-axed. The pole-axe consists of a steel instrument shaped like a large punch, attached to a long strong handle. The ox is led by a rope round its neck or driven into the slaughter-house, and the rope being run through a ring in the wall near the floor at one or more (according to the number of oxen being slaughtered and dressed at one time) particular parts of the slaughter-house, the head is drawn down to a level convenient for the reception of the blow. Sometimes the rope is held by an assistant, and sometimes the animal is blindfolded. Taking a good aim, such as only long practice will ensure, the slaughterman with one swing of the pole-axe drives it into the centre of the crown a couple of inches in front of the horns, and the ox instantly falls heavily upon the floor. By the opening thus made, a long cane is run into the vertebral canal. As the animal lies on its side, the slaughterman then drives a knife deeply into the carcase above the sternum so as to cut thoroughly into the large vessels behind that part, and the blood gushes out freely. When it begins to run feebly, the slaughterman presses upon and kneads the abdomen and sternum so as to promote the flow and press the blood out. The blood, as it flows, is received in shallow iron vessels and set aside, or it is allowed to flow out upon the floor of the slaughter-house and into what is termed a blood-hole, that is to say, a sunken paved or cemented receptacle the size of which varies in different slaughter-houses. In this process a certain quantity of blood rarely fails to flow upon the pavement and into the drain. The carcase when sufficiently bled is then turned over upon the back, in which position it is supported by what are termed "prytches." A prytch is a stout stick of wood about 2 feet long, provided at each end with a stout iron point. The point at one end is forced against the carcase, while the other point is slipped into little shallow holes in the floor which are termed "prytch-holes." An incision through the skin is then made along the whole length of the carcase, the skin is turned back sufficiently, and the abdomen opened and partially disemboweled. The head and neck are flayed, the horns are chopped off so as to be left upon the hide, and the head and feet are cut off. The sternum is sawed in the middle line along its whole length and the symphysis of the pubes also. The ends of a stout wooden bar are then introduced between the hinder leg bones and the tendons, and by this bar the carcass is hoisted head downwards into a perpendicular position by means of pulleys. The disembowelment and the flaying and dressing are then proceeded with. The omentum containing fat is cut off and hung on a hook to cool, and other portions of the folds of peritoneum containing fat are similarly removed. The portions of intestines to which fat is attached are removed to a table where the fat is cleaned off and set aside for the fat melter. The paunch and second stomach are separated; the former is opened and the contents removed, being either thrown upon the floor of the slaughter-house or put into an appropriate receptacle, and the paunch is then hung up on a hook. The second stomach is set aside for preparation as dogs' meat. The intestines, when freed from fat, if not otherwise required for pigs' or dogs' food, go away with the manure. Of the thoracic viscera the heart is used for human food, while the trachea and lungs are hung up for use as dogs' or cats' food. In this process more or less blood and other animal fluids and manure are spilt upon the floor, varying with the degree of carelessness of the slaughterman—the spilling of more or less is inevitable.

of sheep,

b. In slaughtering a *sheep*, the animal is laid upon its side and a knife is run through the throat so as to sever the larger vessels. The blood is usually collected in an appropriate vessel. Where several sheep are to be slaughtered they are commonly laid side by side upon a wooden stand or table having a channel at one end leading to a spout or opening. The throat is cut over this part of the stand and the blood flowing out is collected in a vessel below. The dead carcass is then lifted off and laid on the back upon the floor, and an incision is made through the skin along the whole length of the abdomen and neck, the skin is partly turned back and then the carcass is hung up by the hind legs upon hooks. In this position the flaying is completed, and the viscera are removed and thrown upon a table, where the fat is removed for the fat melter, the paunch is cut open and its contents emptied out either into an appropriate vessel or on to the floor, and it is then hung up; the small intestines are set aside in a tub for the gut scrapers or with the remainder of the viscera sent away with the manure and garbage or set aside for the food of dogs or pigs. This process is not necessarily a very uncleanly one: little or no blood or animal fluid need be spilled upon the floor. The carcase is then dressed for sale.

of pigs.

c. *Pigs* are slaughtered by running a pointed knife into the throat in the middle line, directing it towards the large vessels of the thorax. The blood is either collected in appropriate vessels for use, or allowed to run into a blood-hole in the slaughter-house. In some large pig-killing places the practice obtains of first stunning the pig by a blow from a heavy mallet upon the head. In this way the noise otherwise associated with pig killing is avoided. At Harris' establishment at Calne, where as many as 150 pigs are killed in one morning before 7 o'clock, the arrangements are as follows. The pound, slaughter-house, and singeing oven adjoin one another, and there is an iron rod extending overhead from the pound through the slaughter-house to the singeing oven. Mr. Harris objects to the use of the mallet, because while preventing or lessening noise it bruises the eye pieces, rendering these parts, he says, unsaleable. A chain is slipped round one hind leg of the pig in the pound, and it is then hoisted by a pulley and hooked on to the iron bar, which slopes downwards a little from the pound. The struggles of the animal thus suspended head downwards cause it to slide into the slaughter-house, and bring it over a blood-hole in the floor, leading to a tank below. Here, close to the wall, the pig is steadied and stuck; much of the blood runs into the blood-hole, and as the animal struggles it slides on a few yards towards the singeing oven, blood still flowing from the throat, and being scattered a little about by the animal's struggles. Most of it, however, falls into a shallow channel in the seamless, non-absorbent pavement, which channel leads to the blood-hole. After singeing, washing, and scraping, the carcass is again suspended by both hind legs upon another rod, and opened by cutting along the middle line of the abdomen and eviscerated. The bladder is carefully removed, the urine squeezed out, and then is thrown into a pail of water prior to preparation for the reception of lard. The intestines are removed and thrown down a hopper into a room below; the thoracic viscera are removed and hung upon hooks against the wall. The fat lining the abdominal parietes, and that about the kidneys, is carefully stripped out and hung up above the carcass, and the whole is then run along the same rod to another part of the building near the ice house to cool and set.

3. The disposal of the blood, offal, and garbage.

3. The disposal of the blood, offal, and garbage.

The *blood* is dealt with in one of three or four ways. 1. Pigs' blood is sometimes used as food, being, with portions of fat, run into sausage skins and boiled to make what are termed black puddings. Sheeps' blood is, in some parts of the country, similarly utilised. 2. Or the blood is used as food for swine. I have several times seen it thrown upon the dung-heap in the yard to which pigs kept by the butcher have access. Sometimes it is sent away in barrels to pig-keeping establishments, and, either alone or mixed with other kinds of food, given to the pigs. 3. It is collected in pails or similar deep vessels and stirred or whipped with a bundle of twigs to remove the fibrine. The fibrine is put with other garbage, and the beaten blood is transferred to a barrel in which it is sent away either to persons who prepare it for use in Turkey red dyeing, or (as I am informed) in some instances to the cider merchant. 4. The blood collected either in shallow or deep vessels, as may be most convenient, is allowed to coagulate, and in this condition is sent away to the manufacturers of blood albumen. It is often arranged at public abattoirs that a manufacturer has part of the premises in occupation for the performance therein of the first process of the manufacture. This is the case at Deptford, Manchester, and Croydon, and at one of the semi-public abattoirs at Leeds. At the Metropolitan Cattle Market such manufacturers have establishments just outside the market area. When the establishment to which the blood is to be sent is at a distance, blood casks are commonly used, and they pass to and fro between the slaughter-house and the manufactory either of albumen or manure.

The *tripes* (1st stomach) of sheep and oxen are slit open and their contents emptied either on to the floor of the slaughter-house or on to the surface of the yard outside or into appropriate vessels. In the first case these matters are swept up into a corner of the slaughter-house and often left there with blood and other matters swept up with them until the end of the day.

The second stomach is set aside either in a corner of the slaughter-house or yard, or in some appropriate vessels, until sent away for food of dogs or pigs.

The *small intestines* (running gut) are stripped from fat and put into a barrel or cask for removal to the gut scrapers, or, if there be no gut scraper to take them, they, with other gut, for which no other use can be found, are thrown upon the dung-heap or sent away with other garbage or used as food for pigs. The large intestines of pigs are used as human food, the small intestines go to the gut scrapers or are scraped on the pig killer's own premises for use as sausage skins.

The *hearts, livers, and lungs* are set aside and hung up in preparation for sale either as food for man or animals.

Hides and *skins*, and the feet of oxen, are usually laid aside in some part of the premises until they can be removed by the dealers in those articles. Hides go to the tanner, skins to the fellmonger, and the feet of oxen to the tripe boiler.

The *fat* is hung up on hooks if the pieces be large enough. Small pieces are usually put into a bag. In towns the fat is usually speedily removed from the premises by some fat melter who collects it, but in country villages it may remain for several days, long enough in the summer time to become offensive. Pig killers render the fat into lard upon their own premises.

Sources of effluvium nuisances.

The effluvium-nuisances arising in connexion with slaughtering are usually confined to the immediate neighbourhood. They may depend 1. On the uncleanly manner in which the animals are kept prior to slaughter, and (especially if sheep) to the peculiar odour arising from the animals themselves when they are kept in an open yard close to the windows of inhabited houses. 2. On the uncleanly condition of the slaughter-house (a condition which is aggravated when it is not properly paved and drained) or an uncleanly mode of conducting the several processes of slaughtering. Where there are no proper means of drainage, blood and filth may flow out upon the surface of the ground outside the slaughter-house, and there, stagnating and becoming decomposed, they may give rise to offensive effluvia. 3. On the retention and accumulation upon the premises of hides, skins, blood, fat, offal, dung, and garbage, which after a time varying with the state of the weather undergo decomposition and become offensive. 4. On the uncleanly condition of blood tubs or other receptacles either kept in the slaughter-house or in the yard. 5. On blood and other decomposable animal liquid matters flowing into drains with which untrapped drains, or imperfectly trapped drains, of other premises communicate directly or indirectly. The utmost care is necessary to prevent a slaughter-house in a populous neighbourhood becoming a nuisance.

In South Shields, where sheep and oxen are slaughtered in the shop forming part of the dwelling-house, it is customary to see a blood-hole about 2 feet square and 18 to 24 inches deep in the middle of the shop floor. In this at the time of slaughtering the blood is collected, and the practice is to throw in sawdust, with the object of sopping up the blood, so as to permit of the blood being readily removed the following morning by the public scavenger. Most of the blood-holes I saw, however, had not been thoroughly emptied and cleansed, enough blood having been left at the bottom and corners to give rise to putrid emanations, especially in the warm weather. In some of these cases, the chief supply of air to the dwelling-house was through the shop, and the odour of an ill-kept slaughter-house was perceptible in most parts of the residence. Similarly the effluvia from the animals pounded within the house must diffuse themselves throughout it, and probably give rise to a condition of the atmosphere practically identical with that arising from human overcrowding, and calculated to bring about similar evil consequences.

These nuisances may be injurious to health.

The nuisances above referred to may, by their operation on the senses, produce similar functional disturbances to those which evil odours from other sources are apt to occasion, and in so far as they are filth nuisances, they are unquestionably injurious to the health of persons exposed much to their influence.* Considering the loose and unwholesome manner in which slaughtering is carried on at South Shields, I asked of Dr. Spear, the Medical Officer of Health there, and of some other medical men practising in the neighbourhood the opinion which their experience had led them to form as to the injury inflicted thereby upon health. Dr. Spear tells me that he has arrived at a very decided opinion on the subject, and has consequently (but hitherto fruitlessly) moved the local authorities of the districts for which he has been appointed to provide a public abattoir, and thus to place themselves in a position to deal with the unwholesome slaughtering places in their several districts more efficiently than they can now deal with them. He says that in his experience during the two years that he has held office, the houses where slaughtering is carried on have been chief foci of zymotic diseases, and that in tracing back outbreaks of such diseases in the town he has, on more than one occasion, traced back the infections to these houses, and has been unable to trace it back farther; and that, in common with many of the medical practitioners, he is of opinion that the course of zymotic diseases and the type assumed by them have been unfavourably influenced by exposure to the slaughter-house effluvia. There appears, moreover, to be a general impression among medical men that women living in the houses where they are exposed to these effluvia make bad recoveries after child-birth. Dr. Bradley, of Jarrow, told me that so strongly was he impressed with this fact as the result of a long and extensive obstetric experience, that it was now a rule with him to advise women approaching their confinements to quit such places. He could not say that the women suffered as the result of their surroundings from puerperal fever or definite disease after their labours, but they had "bad gettings up," that is to say, their recovery was tedious, and interrupted by undefined ailments, such as irregular attacks of feverishness, headache, want of appetite, &c. &c., which led them to require more medical attendance than is customary after confinements, and which kept him often in a state of anxiety.

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* Dr. Alfred Carpenter has stated his belief ("Lancet," 1871, Vol. I., and "Public Health," April 1874) that blood and garbage from slaughter-houses, when undergoing decomposition, may cause the development of scarlatina in persons exposed to their effluvia. He lays considerable stress on the influence of decomposing vertebrate blood in giving origin to this disease. To my mind the observations he has recorded fall very far short of affording proof of his proposition. But as the opinion of Dr. Carpenter has attracted (as any opinion he may broach deservedly attracts) professional attention, I feel bound to notice it here. I have inquired of several health officers, on whose judgment I could rely, and who knew of Dr. Carpenter's paper, as to their experience of such a relationship between scarlatina and slaughter-house effluvia, as Dr. Carpenter suggests, but none of them felt themselves in a position to affirm it. Dr. Spear, of South Shields, however, told me that in two instances during the two years he has held office, he had traced back the infection of local outbreaks to butchers' premises, being unable to trace it back any farther; but he properly hesitated to say that this was anything but an accidental circumstance, of that a similar apparent origin might not in other instances have been traced back to, say, the premises of a grocer. I must say, nevertheless, that Dr. Carpenter's hypothesis is, in my opinion, worthy of closer investigation than it has yet received.

directly or indirectly by damaging the quality of meat.

And there is also another less direct way in which the effluvia from a badly kept and badly managed slaughter-house may conduce to injury to public health, namely, through the influence which the septic effluvia from them may exert upon the recently killed meat. It is a common practice in England to hang up the dressed carcases to cool and "set" within the slaughter-house. When the slaughter-house is too warm or charged with septic effluvia the meat not only cools slowly and sets slowly, but is liable to imbibe septic matters from the slaughter-house atmosphere. Keeping animals pounded in the slaughter-house itself, is calculated to maintain too elevated a temperature, and septic effluvia must be abundantly present in the air when the slaughter-house is badly kept and badly arranged or managed; such effluvia, for instance, may originate from the pound, either when within the slaughter-house or freely communicating with it, from blood or filth left in the slaughter-house, encrusted upon the walls or lying in the fissures of the flooring, from skins or fat too long retained, or from a drain having its inlet within the slaughter-house itself. And such slow setting of the meat and absorption of septic ferments are apt to conduce to early decomposition of the meat, especially in the warmer season of the year, or when the meat is the produce of animals which, although diseased, are not so diseased as to render the meat in the opinion of judges of meat unfit under favourable circumstances for human consumption. Putrid meat, meat obviously tainted, is carrion, and probably would hardly find a purchaser; but it is well known to medical men that some meat apparently good and wholesome, meat not obviously tainted, may produce when cooked and eaten very serious disturbance in the system of the consumer, symptoms distinguishable with difficulty from choleraic symptoms or symptoms of irritant poisoning. I have seen some such cases myself; and it has been believed that the functional disturbance has been due to some alteration in the meat, possibly in the fat, having affinity with putrefaction, but not itself the ordinary putrefaction which betrays itself by odour. It has appeared to me not improbable that the septic ferment present in all ill-managed slaughter-houses in which the meat has cooled and set slowly, may in some cases have been concerned in bringing about this result. I have never attained absolute proof of this, but the possibility of the occurrence is sufficiently clear to impart a caution of a practical kind.

Mode of preventing nuisances from slaughtering.

The essentials of slaughtering so as to avoid nuisances are scrupulous cleanliness of the slaughter-house and pound, of the atmosphere of both, and of all utensils, and the speedy removal of all decomposable matters. The business ought to be so worked that, except during the time when actual slaughtering is going on, there should be no unpleasant odour of any kind perceptible within the premises or proceeding from them. In order to ensure these results much care is requisite in respect of details of construction of the buildings, and in respect of the mode of conducting the business.

1. By due arrangement and construction of slaughter-house.

1. As to the arrangement and construction of the buildings.

1. The slaughter-house and pound should not be contiguous to any inhabited buildings; *à fortiori*, they should not, either of them, be within a dwelling-house or directly or indirectly communicating with one. The slaughter-house and pound should be two distinct and separate buildings, or should at least be capable of being entirely shut off from each other. 2. The inner surface of the walls of both should be of brick or stone, and the surface should be covered with a layer of limewash which can be renewed from time to time. The lower parts of the wall to the height of 5 or 6 feet should be covered with smooth cement, slabs of slate, zinc sheeting, or some similarly impervious material capable of being washed clean with water. At Mr. T. Harris' slaughter-house at Calne, where, from the mode of killing, blood becomes scattered high upon the wall, the whole of the walls are covered with a smooth cement. There should be no exposed woodwork within the slaughter-house; any woodwork which there may be should be covered with a layer of paint or tar or zinc sheeting. 3. The flooring of the slaughter-house should be of some uniform material, sufficiently even to be capable of ready and thorough cleansing with water and a brush, and sufficiently rough to avoid slipping upon it. At the same time it should be firm and incapable of giving way under the fall of heavy beasts, or of breaking under rough usage. Paving with York flagstones set with cement is the paving most commonly met with both in London and in the country; and it is I find generally preferred by many slaughtermen, whose opinion is worth having, to any other paving of a jointed character. If used it should be laid upon a firm basis of 4 to 6 inches of good concrete. But the objections to it are its slipperiness when blood and other matters from the animals slaughtered become spilt upon it, the tendency there is to the cracking and loosening of the stones (when blood or other liquids may percolate between them and through the cracks), and the frequent loosening and breaking away of the cement with which they are set, partly as the fault of the slaughtermen who commonly use the intervals between the stones for the support of their prytches, instead of using the prytch holes provided in the surface of the stones themselves. The best paving of all is an even jointless paving, sufficiently hard and firm to resist rough usage, and sufficiently rough not to be slippery. Such a pavement is furnished by some concrete and some asphalte compositions. For example, I recently saw at Newcastle-on-Tyne 17 slaughter-houses forming an abattoir constructed in 1869 by a private company, and which have been in use ever since for the slaughter of horned cattle and sheep. The flooring of these and of the approaches to them is made of a cement laid down by Wilkinson & Co., of Newcastle. It consists of good Portland cement, mixed with roughly ground stone or granite laid upon a basis of small brick-bats, the whole thickness of the flooring being about 3½ inches or 4 inches. It had worn admirably, was free from slipperiness, and had not cracked anywhere. It was very readily cleaned, and was as perfect a flooring for a slaughter-house as could be devised. The butchers using the slaughter-houses spoke of it in the highest terms of commendation. Ordinary asphalte is unfit for use in slaughter-houses; it is too soft in the summer, and readily yields to blows or pressure. It has been a failure wherever I have seen it laid down. But

App. No. 6.

On Effluvium-Nuisances, by Dr. Ballard.

at West and Hayr's private slaughter-house at Croydon I saw last year a flooring of asphalte composition, which had been laid down by Claridge's Patent Asphalte Company, and which appears to meet all the requirements of an extensive business. When I saw it in November it had been in use for eight months, had not softened at all by the summer heats, and showed then no signs whatever of wear, although I am informed that about 80 beasts and 500 sheep on an average had been slaughtered upon it weekly. It was rough enough not to be slippery and was very firm and hard. It was laid upon concrete made with cement. The prytch-holes were iron thimbles imbedded in the composition before it hardened. A good cement pavement may also be seen at Mr. Whitlaw's, Seven Sisters Road, in the north of London, which is in as good condition now as when it was laid down nine or ten years ago. Both beasts and sheep are slaughtered at this place. When first it was laid down it was slippery, but this was obviated by ridging the surface a little. It has never required any repair. With a jointless paving and with the wall-surfaces protected as I have recommended, it is possible to maintain perfect cleanliness and sweetness of the whole inner surface of the slaughter-house. 4. The paving should be so sloped as that liquid matters shall run off to a proper channel leading to the inlet of a duly laid pipe drain. This inlet should be outside the slaughter-house and should be provided with means of arresting the flow of anything but liquid matter into the drain. 5. Slaughter-houses and pounds should be separately and very freely ventilated, preferably by louvres at the roof or in opposite walls, so as to provide for a horizontal movement of air across all the upper part.

2. By proper mode of conducting the business.

2. As to the conduct of the business.

1. During the process of slaughtering as much care as possible should be taken to prevent the discharge of blood or other animal matters upon the floor of the slaughter-house. The emptying of the contents of the viscera should, where practicable, be performed in a separate place, and any filth should be swept up from the floor and taken away at short intervals. 2. Hides, skins, blood, fat, offal, dung, and garbage should be removed from the slaughter-house as speedily as possible, and while they remain on the premises should be so kept as not to become sources of nuisance. Where hides or skins are necessarily retained for a day or two before they can be removed, they might without injury be advantageously (especially in the summer) brushed over on the fleshy side with a solution of carbolic acid or some other antiseptic. Fat should be freely exposed to the air in a cool place. Blood, offal, dung, and other garbage should be placed in covered, movable receptacles constructed of galvanised iron or other non-absorbent material. Such articles as have been last mentioned should be, under any circumstances, removed from the premises, without undue delay, in the vessels in which they have been placed. A dung pit, as a substitute for immediate removal, need not be requisite in any urban sanitary district properly administered. 3. Immediately slaughtering is completed, the whole slaughter-house floor and walls (to the height of the impervious portion) should be thoroughly washed with water, and the pound thoroughly cleansed. All the vessels and implements used in the slaughtering, or brought from outside into the premises, should be made and kept clean and sweet. The inner walls of the slaughter-house and pound should have their surface periodically renovated by lime washing.

THE SLAUGHTERING OF HORSES.

ESTABLISHMENTS VISITED.

THE SLAUGHTERING OF HORSES.
Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875, and subsequently.	Harrison - -	Belle Isle, Islington.	Boiling of flesh, &c.
Dec. 11, 1875	Shaw - -	St. George's Southwark.	Do.
Jan. 21, 1876	Kent - -	Bristol - -	Do., artifical manure making.
April 1 „	Town - -	Melton Mowbray -	Artificial manure making.
Dec. 4 „	Glen Park knackery.	Glasgow - -	Boiling of flesh, &c.
„ „ „	Hodgkinson -	Do. - -	Do.
Jan. 10, 1877	?	Near Portsmouth -	Do., pig-keeping.
„ 19 „	Stronach - -	Belle Isle - -	Boiling of flesh, &c.
Feb. 13 „	Adams - -	Birmingham -	Do., preparation of white leather.
Mar. 27 „	Arthur - -	Greenock -	Boiling of flesh, manufacture of animal charcoal, artificial manure making.
„ 15 „	Walton - -	Cambridge -	Boiling of flesh, manure making, pig-keeping.

Knackeries.

The establishments where horses are slaughtered are termed "knackeries." Diseased oxen or sheep which are manifestly unfit for human food are also often and properly slaughtered in these establishments. Knackeries are sometimes situated, as in London, in populous but poor neighbourhoods. In the country they are usually located in the suburbs of towns. Those I have seen vary greatly in character, as in size. In London, Glasgow, and some large towns they are large, more or less well-arranged establishments, and are often conducted either without creating effluvium-nuisances or with little creation of nuisance. But in out-of-the-way parts of the country, and even sometimes in the close vicinity of towns, the slaughtering of horses is conducted in small and very ill-arranged and ill-constructed places, where the nuisance they occasion in one way or another is much complained of. The business of a horse slaughterer may be considered under similar heads to that of a slaughterer of oxen and sheep.

The business of a knacker described.

1. As to the keeping of the animals prior to slaughter.—The animals are sometimes brought to the slaughterer in larger numbers than he can dispose of on the day they are brought, and horses may have to be kept by him and fed for one or more days before it is convenient to kill them. Besides, the knacker not only receives live animals for slaughter, but as a legitimate part of his trade dead ones also, animals which have died from disease or accident or which have been slaughtered elsewhere; and for such dead carcases he must provide a place, and he must, to avoid nuisance from their decomposition, dispose

1. Keeping of animals prior to slaughter;

a knacker also receives dead animals.

of their carcases before he can deal with the living animals on his premises. In seasons of epidemic disease his yard may be so overloaded with these carcases that the work of disposing of them has to go on both by night and by day. In the time of the cattle plague in 1865 so many carcases of cows were received by one of the largest knackers at Belle Isle that they had to be buried, and were buried in large numbers on the premises. The pound for living animals is usually an enclosed covered and paved space apart from the slaughter-house. In small establishments there is often no pound, the animals awaiting slaughter being merely tied up in some part of the yard.

2. Actual process of slaughtering;

2. As to the actual process of slaughtering and disposal of the flesh.—Horses are first pole-axed and then bled, after the manner of oxen, by cutting down above the sternum, and the blood is collected in vessels for various purposes. The carcass is then laid upon the back, and, the legs being held up by ropes to a beam above, is flayed, the feet are cut off, the viscera are removed, the subcutaneous fat is cut off separately, all the flesh is cut off the bones, and, finally, the skeleton is broken up. The slaughter-house in which the animal is killed is usually paved all over, although not always in the same way or with the same material in all parts; and a part of the area is appropriated to the boiling of the flesh and fat. Bone boiling, then, is one of the processes carried on at a knackery, and so also is the boiling of flesh for dogs' and cats' meat or for manure, and for the extraction of the fat. When the process of bone-boiling is carried on, it differs in no essential respect from that pursued at ordinary bone-boiling establishments, so that what I may have to say upon this subject will be said when I come to treat of this trade; but it is not unusual for the bones to be sent away to a professed bone-boiling establishment. The boiling of the flesh and of the fat (with water) will be described under the head of "Boiling of Flesh, &c."

other processes carried on.

3. The disposal of the offal and garbage.

3. As to garbage and offal. The only parts of the animal (except bones) sent away unboiled from the premises are the feet (from which the iron shoes are first removed); the tails, after all hair has been cut off, and the manure found in the carcass. The intestines are first emptied of manure and then boiled for dogs' meat. Fœtusses found in the carcass are usually sent away with the manure.

Sources of effluvium nuisances.

The effluvium-nuisances from knackeries may proceed from various sources: 1. The pound, if ill-kept, and especially if a number of diseased animals be kept there for any length of time, may be a source of nuisance from the effluvia of the animals themselves, and of their excreta. 2. The slaughter-house may be a source of offensive effluvia if it be dirty and kept in an uncleanly condition. 3. Dead animals on the premises may give rise to effluvia by their decomposition before being flayed and boiled up. 4. The dung and garbage may also be a source of offensive effluvia, either while retained on the premises or while in process of removal. 5. The steam issuing from the pans always has an odour which, never anything but unpleasant, may, when the matters boiled have undergone any amount of decomposition, become absolutely nauseous, and the offensive odour may extend a long distance from the knackeries. The steam issuing from the hot flesh removed from the pans and laid to cool is similarly offensive. 6. When the liquor from the pan is run off by open channels, similar offensive smells are given off, and when run off hot into drains may give rise to offensive effluvia from neighbouring drain inlets communicating with them. Where other trades are associated with that of a knacker upon the same premises, the effluvium nuisances observed may proceed in part or entirely from these trades. Thus in two instances, one at Melton Mowbray and one near Cambridge, I found that the principal source of nuisance was manure making, and at two offensive establishments, one near Portsmouth, I found that swine were being kept in a most filthy condition, and fed, in part at least, upon the blood and offal of the knackery.

In so far as they are filth-nuisances, they are injurious to health.

Most of these sources of effluvia are of the nature of filth nuisances, and like those effluvia which proceed from places where animals are improperly kept, or from slaughter-houses, must be regarded as calculated to injure the health of persons much exposed to them. Even casual exposure may give rise to nausea and temporary functional disturbance arising from the impression made upon the senses. Nevertheless it is quite practicable to carry on this offensive trade in such a manner as not to be a nuisance, or with only a minimum of offensiveness.

Mode of preventing nuisances.

1. The premises should be sufficiently isolated, as recommended in the instance of slaughter-houses. 2. They should be sufficiently capacious, not only for the ordinary amount of business carried on, but to meet the exigencies of season and epizootic outbreaks, by affording accommodation, without inconvenience to the operations of the knackery, for as many dead animals as are likely under any circumstances to be brought in. 3. The arrangements of the buildings should be approximated in principle (*mutatis mutandis*) to those recommended in the instance of slaughter-houses, *i.e.*, (*a*) The pound should be duly paved, well drained, well ventilated, well lighted, kept very clean and periodically limewhited; *b.* the slaughter-house should be firmly paved on concrete with an impervious and preferably jointless pavement, properly sloped to a channel leading to a properly trapped drain inlet furnished with due arrangements for arresting solid matters; the walls should be rendered impervious by covering them evenly with cement to the height of at least 6 feet from the floor, and all woodwork to the same height should be covered with sheet zinc; and the slaughter-house should be well ventilated and lighted, preferably from the roof; *c.* the yard should be capacious, well and evenly paved, and duly drained, and provided with open sheds for the protection of carcases deposited there from the rain and direct rays of the sun. 4. The business should be conducted in as cleanly a manner as possible. *a.* No dead animals should remain undealt with upon the premises longer than 24 hours, at any rate in the summer time, and, at all seasons, the carcases should be disposed of before they undergo putrefaction. Carcases which may be in a state of putrefaction should not be received at all; they should be buried; or if received, or if they should chance to become putrid after reception, should be dealt with otherwise than in the manner customary in English knackeries.* *b.* Proper impervious

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* One mode of dealing with such putrid carcases might be to flay them and divide them sufficiently, to deodorise the skins by the application to the fleshy side of an effective deodorant, and, after similarly deodorising the flesh to deal with the pieces into which the carcass has been divided in the mode which I have seen employed in a knackery near Paris. In this establishment there was in use a strong iron cylinder capable of containing the carcases of two or more horses. Into this cylinder steam was introduced under pressure. After a short time the whole of the soft parts were converted into a pulp, which was run off into trenches to solidify and dry, and the pulp was subsequently dried and pulverised for the manufacture of manure. The bones were discharged clean and ready for the use of the bone-manure maker.

covered vessels or barrows or carts should be provided for the reception of viscera, skins, and bones or manure prior to their being further dealt with, or for conveyance to the parts of the premises at which they are to be dealt with, or for conveyance from the premises elsewhere, and such receptacles should be duly used. There should be no such thing as a dung-pit or dung-shed; everything of the nature of refuse should be removed daily from the premises in the covered receptacles in which they are first placed. *c.* As much care as possible should be taken to collect all the blood so as to avoid its entrance into drains. With this object it is desirable that carcases brought in dead should not be dealt with while they are yet warm, nor until it is probable that the greater part of the blood in the vessels has coagulated. *d.* The floor of the slaughter-house should be kept constantly swept up and the garbage removed, and at the end of each day's work it should, with the walls to the length of the impervious portion, be well washed with water, of which there should be an abundant supply stored at a sufficient elevation to allow of the use of a hose. The inner walls should be kept sweet by periodical lime-washing. *e.* The boiling of the flesh and fat should be carried on with due precaution for the avoidance of the escape of the resultant offensive vapours into the external atmosphere. The means of attaining this object are the same as those which will be mentioned under the heads of "flesh, tripe, and trotter boiling" and "fat melting." *f.* The issue of offensive vapours from the meat or intestines when removed from the boiling pans, may be obviated by throwing them at once from the pan into a trough of cold running water for a few minutes. *g.* The liquor in the pans should be allowed to become cold before being run off into drains.

Part III.
On Effluvium Nuisances arising from other businesses in which Matters of Animal Origin are dealt with.
The Curing of Bacon.
Establishments visited.

Part III.

On Effluvium Nuisances arising in Connexion with Branches of Industry in which Animal Matters or Substances of Animal Origin are principally dealt with.

The Curing of Bacon.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Jan. 19, 1876	Williams - -	Bedminster -	Slaughtering of pigs.
„ 21 „	Skull - -	Bristol - -	Do., rendering of lard, boiling chitterlings, &c.
„ „ „	Dole - -	Do. - -	Do.
„ 29, 1877	— Day - -	Reading (Cross Street).	Do.
„ „ „	— Day - -	Reading (Munster Street).	Do.
„ „ „	Thomson - -	Reading - -	Do.
„ 30 „	Thomas Harris -	Calne - -	Do., gut scraping.
„ „ „	C. Harris & Co. -	Do. - -	Do.
Mar. 22 „	Humphrey and Evans.	South Shields.	
„ „ „	Nicholson -	Do.	

Varying size of curing establishments.

The establishments at which the making of pork into bacon is carried on vary very much in size and commercial importance. For example, at Calne there are two very extensive establishments, viz., that of Thomas Harris and that of Charles Harris & Co., where as many as 150 pigs are killed in one morning for conversion into bacon, and at Cirencester there is a similar large establishment, all of which I have visited. At Reading, on the other hand, where a large quantity of bacon is made, we have examples of a large number of small establishments, where only four or five or even fewer pigs are killed for bacon at one time, and where pork butchers engaged in this trade perform part of the process for other persons, such as grocers, who perform the earlier parts of the process on their own premises.

General description of the trade.

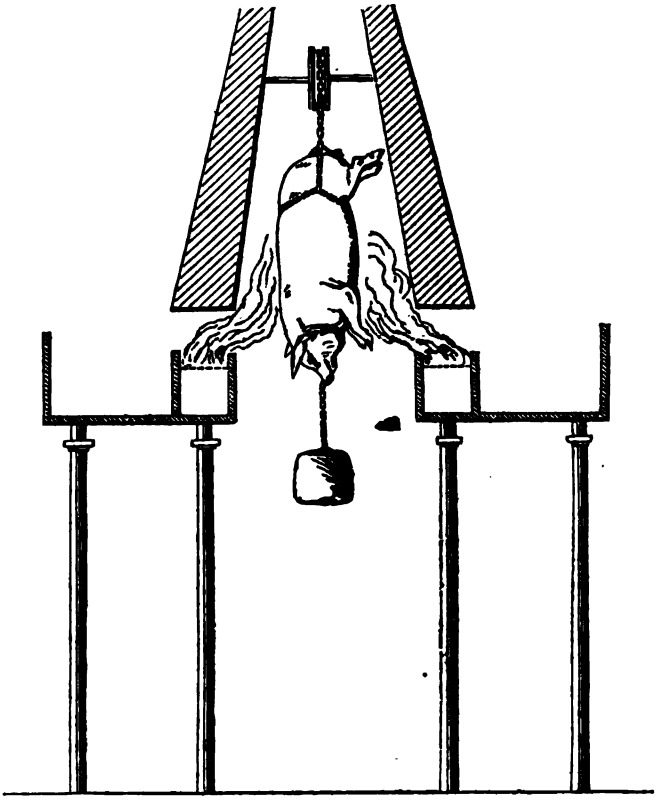
Persons who, as a matter of trade, make bacon also keep pigs, some for fattening, but some only for fasting prior to slaughter; and after slaughter not only cure the bacon, but render the lard, prepare or cook chitterlings, and commonly scrape the small intestines for the preparation of sausage skins. Hence an effluvium-nuisance proceeding from a bacon manufactory is not necessarily one arising directly from any process of actual curing, but may be due to one of these associated circumstances of the trade. The work carried on at a bacon-making establishment commences with the slaughter of the pigs. After slaughtering, the hair is singed off and the singed carcass is washed and scraped to remove the burned hair. The carcass is then disembowelled and dressed, salted down in appropriate cool chambers, and after the salt has been washed off and the surface wiped dry and dusted over with pea-meal, the salted meat is hung up in appropriate chambers to be dried and smoked. The brine which runs from the meat when in salt is collected in tanks, and when of no further use is disposed of in the way that sewage is usually disposed of.

I have already said all that is necessary about the process of slaughtering, including the removal of the viscera and dressing of the carcass, in a former part of this report; and other processes will be treated of when I come to the trades of fat-melting and gut-scraping, and boiling of various articles of food (such as tripe, trotters, &c.), so that I shall confine my description to the two processes of singeing and smoking. There are matters of sanitary interest connected with the salting of the meat, but they have nothing to do with the immediate subject of this report. The singeing off of the hair is performed in various ways in different establishments. In small establishments it is often performed in a very rough manner, namely, by surrounding the carcass or several carcases with straw and then igniting the straw. Wherever I have seen this done in England it has been done in an open yard. Another method consists in applying to the carcass the flames from a coal fire. For the application of this method a special apparatus is requisite, and the form of the apparatus differs in different establishments. At Skull's establishment in Bristol, the carcass is hoisted by a pulley and counterpoise into a sort of chimney shaft supplied with flame by means of two coal fires at the lower part, the whole arrangement being placed on a platform or floor just above the base of the floor on which the pigs are slaughtered. The shaft terminates above in a chimney, the top of which is about 30 feet from the ground. Fig. 1 is a rough sketch of this arrangement.

Operation of singeing,
with straw,
by flame of a coal fire,

At Harris', in Calne, Denny's Patent Pig-singeing Furnace and Apparatus are in use. The carcass, run out head downwards on a rod from the killing place, is taken down upon a fixed bench, where it is suspended horizontally upon a waggon running upon a narrow rail or tramway forming one of four similar arms in a revolving apparatus which allows another carcass to be affixed while the previous one is in process of singeing. This rail corresponds with another at the upper part of the furnace. By this the carcass is then run into a chamber into which the

Fig. 1.



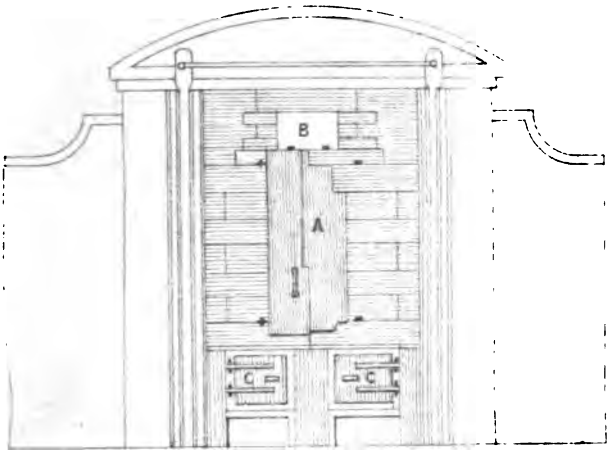
flames pass from two large fires, one on each side. The chamber, during the time the carcass is in it (which is not longer than about 25 seconds), is enclosed in front by a pair of iron doors which, when closed, leave a space of several inches above (where the rail passes in). From this space during the singeing, some of the smoke from the burning hair, together with a little flame, issues into the interior of the building, and finally gains exit by the openings in the roof at a considerable elevation. The greater part of the smoke, however, passes off by the furnace chimney. The accompanying plans, Plates 1, 2, and 3, show the arrangement of the furnace and revolving apparatus. The carcass being run out and a fresh one being run in from the revolving apparatus, the singed carcass is taken down upon a revolving table and is again suspended head downwards upon another bar which conveys it to the washing place. When the carcass is run out, smoke from the singed surface is given off freely into the building, but its issue is checked within a very few minutes by suspending the carcass over a tub and throwing cold water over it preparatory to scraping.

In other establishments the flame of burning gas is used for singeing the carcass. Even in small establishments this may be seen, as for

Plate 1

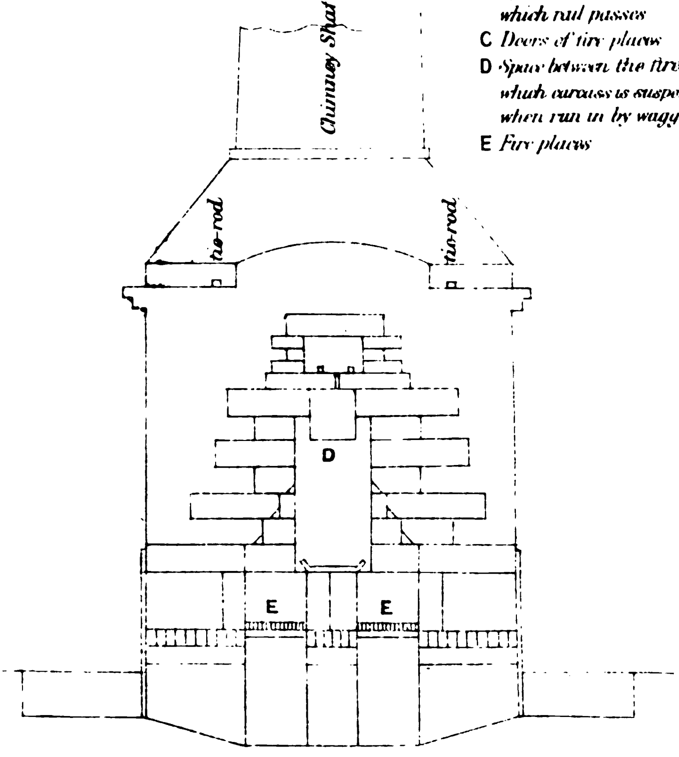
A & E. M. DENNY'S PATENT PIG-SINGEING FURNACE AND APPARATUS.

Scale of Feet



FRONT ELEVATION.

A *Pair of iron doors*
B *Space above doors through which rail passes*
C *Doors of fire places*
D *Space between the fires in which carcass is suspended when run in by waggon*
E *Fire places*



TRANSVERSE SECTION.

Copperfield Lith. 24 Bedford St. Covent Garden.

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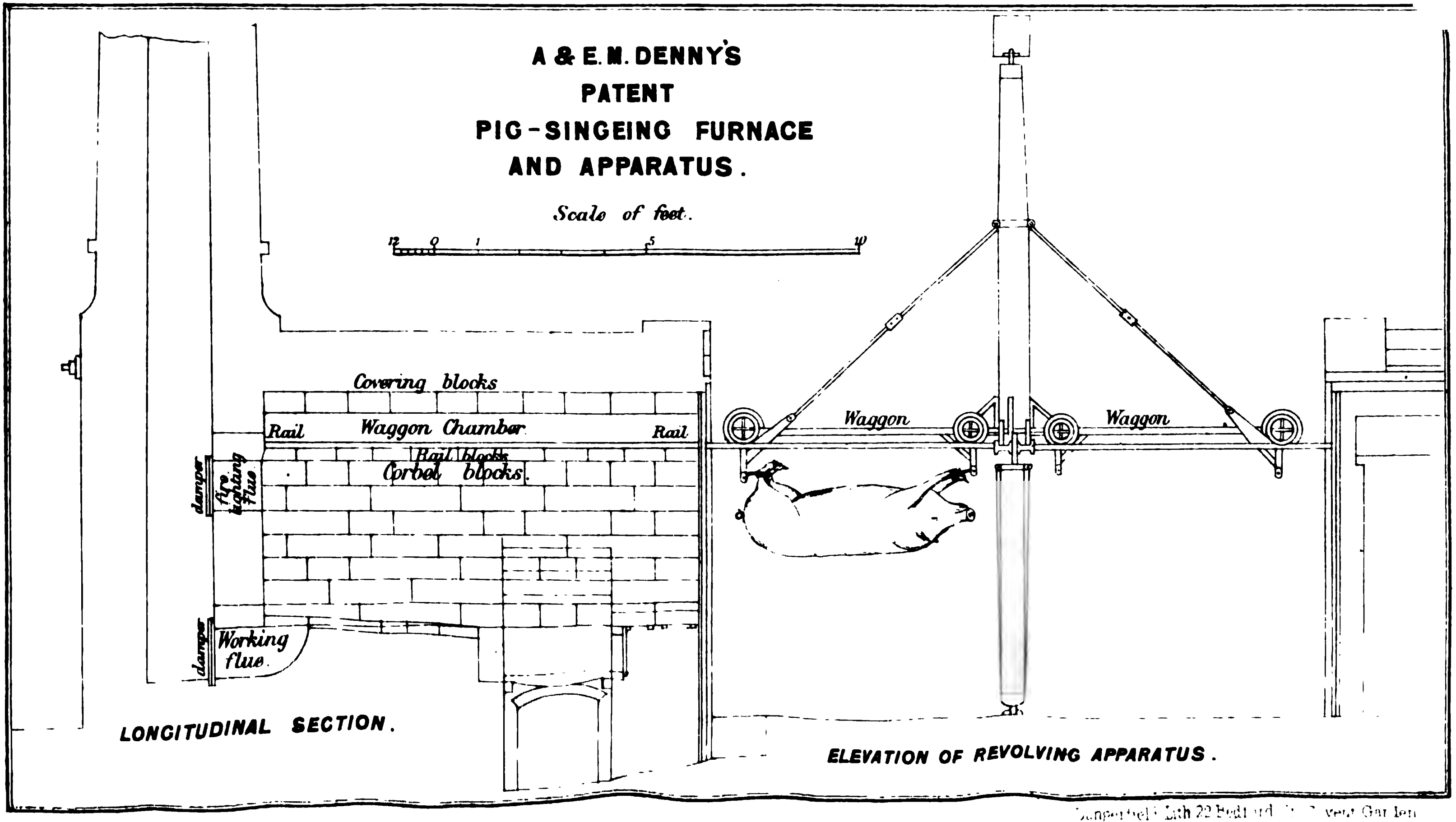
ASTOR, LENOX AND
TILDEN FOUNDATIONS.



A & E. M. DENNY'S
PATENT
PIG-SINGEING FURNACE
AND APPARATUS.

LONGITUDINAL SECTION.

ELEVATION OF REVOLVING APPARATUS.

Dangerfield Lith 22 Bedford St Covent Garden

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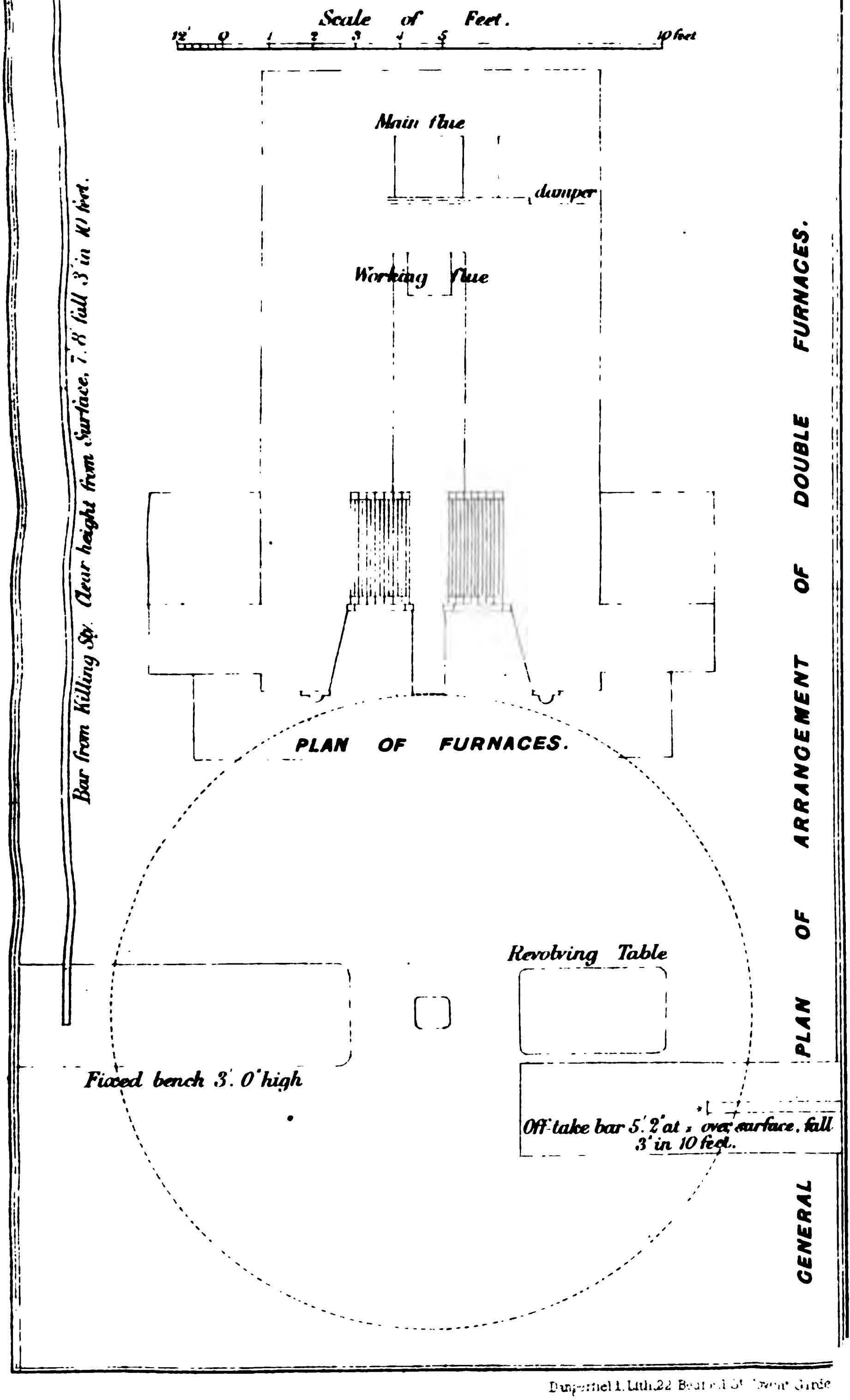
TILDEN FOUNDATIONS.

Plate 3.

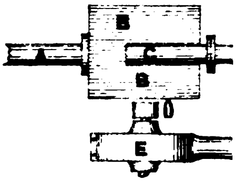
A. & E. M. DENNY'S
PATENT
PIG-SINGEING FURNACE AND APPARATUS.


Scale of Feet.
12
0
1
2
3
4
5
10 feet
Main flue
damper
Working flue
PLAN OF FURNACES.
Revolving Table
Fixed bench 3'. 0" high
Off-take bar 5'. 2" at over surface, fall 3" in 10 feet.
Bar from Killing Sty. Clear height from Surface, 7'. 8" fall 3" in 10 feet.

GENERAL PLAN OF ARRANGEMENT OF DOUBLE FURNACES.

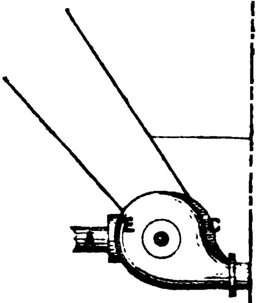
Dunfermline Lith. 22 [illegible]

Pl



A	*Gas Pipe from the Meter.*
B	*Gas Chamber*
C	*Gas Fan*
D	*Gas Pipe*
E	*Air Fan*
F	*Air Pipe*
G	*Mixing Chamber*
H	*Pipe to front half of Burner.*
I	*" back " "*
K	*Flexible Tubes*
L	*Receivers.*
M.	*Gas Pipes & Burners*
N.	*Rod on which carcass travels.*

The dotted lines shew the position of
when open to receive the Pigs.

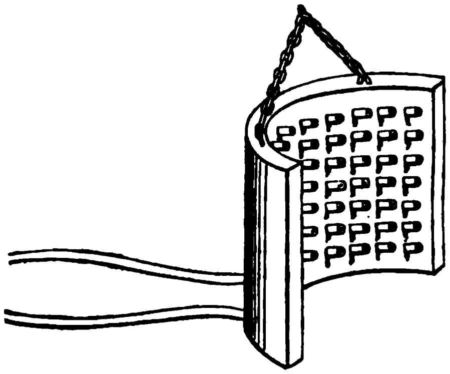


ford St. Covent Garden.

by flame of gas.

example at Thomson's, in Reading. At this establishment the singeing with the gas apparatus is performed under an open shed in the yard of the premises. The apparatus, of which Fig. 2 is a rough sketch, consists of an iron shield in the form of a segment of a circle. It is about 2 feet high and 2 feet diameter. The thickness of the shield contains a hollow space, into which, on the convex side, gas is introduced by one tube while air is driven in by means of a fan or blower through another larger tube. The mixed gases issue by a series of about 100 jets on the concave side, and, after lighting the mixture, the carcass is suspended near the concavity and singed all over by varying the elevation of the shield by a pulley on which it is suspended, and turning the carcass round so as to expose all parts in succession.

Fig. 2.



At Dole's establishment in Bristol a more elaborate form of the same arrangement, constructed by Mr. Miles, engineer, of Bristol, is in use. (Plate 4.) It is set up within the part of the building appropriated to slaughtering and dressing. It consists of two shields of similar construction to that just described, the concavities facing one another, and the shields being of such length and so provided with hinges at the lower ends as to be capable of enclosing the carcass between them. To introduce and remove the carcass the shields are opened out like scissors from the hinges below, and the carcass is run in or out suspended head downwards from a rod above. By this arrangement the singeing is much expedited (80 carcases can be singed per hour), the singeing being effected all round at one time. Practically, however, Mr. Dole finds it sufficient to light the gas from one shield only, and if the side distant from the shield is not sufficiently singed the carcass is turned round for a few seconds, so as to expose that side to the direct action of the flame. The smoke from the singed carcass issuing from the top of the apparatus, together with that from the carcass after removal, passes out by the louvred openings at the roof of the building.

Drying and smoking.

The drying and smoking are effected in chambers provided for the purpose, sometimes of brick, or partly of brick and partly of wood, within which are rods and hooks, upon which the sides of bacon, ham, &c., may be suspended. These chambers have openings above, either louvre openings or trap doors, by which smoke may issue, and by which the heat may be regulated. The heat requisite is about 95° Fahr. It may be supplied (if the bacon is not to be smoked) by a fire of coke or anthracite coal in a brazier, or moveable fire-grate, placed in the centre of the floor; but if the bacon is to be smoked, the heat of burning wood or sawdust is employed, either alone or in conjunction with the fire above mentioned. The wood or sawdust used are preferably those of elm or oak. The erections in which this process is conducted vary in size and elevation, according to the amount of work done at the establishment. In large establishments, like those at Calne, the smoking chambers are very lofty and capacious, but at small establishments, like some I visited at Reading, they were small and low, say 8 feet high and wide, and 4 feet from front to back, and were situated in the back yards of the houses.

Sources of effluvium-nuisances,

Effluvium-nuisances may arise at bacon-curing establishments out of the associated trades carried on in them, such as pig-keeping, slaughtering, rendering of fat, boiling of chitterlings, &c., or gut scraping. But all these sources of nuisance will be considered under the heads of these several trades or processes. The only other nuisances which I have heard complained of seriously have been those arising from the singeing and smoking, and the disposal of the waste brine and other matters from the curing house. But in this last case other liquid matters were discharged with the brine, and probably had much to do with the nuisance. The case was one of defective drainage, the liquid refuse from the establishment having been discharged upon some neighbouring waste land, where it putrified, and became very offensive.

from singeing,

The offensive pungent smell from singeing, however, has sometimes been rather grievously complained of, and at Reading, in one instance, the local authority had occasion to deal with it. The smell is that of burning hair. Under favouring circumstances, as where the operation is performed in an open yard, surrounded with tall buildings, the nuisance has extended to a distance of 50 yards, and has been especially complained of in sultry close weather, when little wind has been stirring, and the smoke has thus been confined within a limited space. Under these conditions it has been described as "nauseating," and as producing "sickness at the stomach," but no more serious injury to health has to my knowledge been ascribed to it. Where straw has been employed for singeing there has been in addition the nuisance from the smoke and from blacks or portions of charred straw falling about in the neighbourhood. This last form of nuisance has led the Reading Sanitary Authority, on the complaint of butchers, who asserted that the blacks rendered their meat unpresentable, to prohibit singeing at the public abattoir. It is obvious that the nuisance from singeing is greater the slower is the method adopted. The more rapid the process, and the shorter the time which elapses between the singeing and the washing and scraping, the less is the nuisance occasioned. The rather irritating vapour and smoke issuing from smoking chambers has also been occasionally made subject of complaint. In both these respects small establishments have, so far as I can learn, alone been complained of, the reasons being the comparative slowness of singeing, from the lack of due appliances for rapid work, and the low elevation at which the smoke has issued in a closely built-in neighbourhood. At Calne, and at Cirencester, and at Bristol the smoke has been no nuisance, having been discharged under circumstances favourable to its speedy diffusion.

from smoking.

Mode of preventing nuisance,

The remedies applicable for preventing or minimizing the nuisance from singeing are, first, the use of appliances for speedy singeing, and washing with cold water as quickly as possible after the singeing has been effected. In the close parts of towns, singeing ought not to be effected by means of straw; singeing with gas or a well planned fire arrangement, as at Calne, and at Skull's and Dole's establishments in Bristol, is much preferable in view of speed and readiness of disposing of the smoke without producing nuisance. The interval elapsing between these two processes of singeing and washing may be abridged by good mechanical appliances. Hence it is better to singe in a position of the carcass which shall not require to be altered for the purpose of washing down. A carcass suspended head downwards from a rod, on which it may be made to travel, is on this ground best singed in this position, and then it can be made to travel on in the same position to the place for washing and scraping, and be washed down with cold water immediately; only a second or two intervening between the two processes. Without invidiously comparing establishments which are not comparable the one with the other, it appears to me that the plan adopted by Dole and by Skull at Bristol may, in this one respect, be, in some situations, preferable to that adopted at Calne. Secondly, when the smoke is produced in an area surrounded by tall houses, and issues at such a level as to enter at the windows of such houses, an effectual remedy will be found in performing all the singeing and subsequent washing within a building provided with a tall chimney shaft, so arranged as to carry off the smoke to and discharge it at an elevation above the tops of adjoining houses. A similar provision (modified for the requirements of the process) to a low smoking-chamber or smoke-house would prevent any nuisance from this source.

from the singeing,

from the smoking.

At South Shields, at Newcastle, Gateshead, and probably in some other places American pork is dried for conversion into bacon. The pork arrives salted, and is sometimes more or less tainted. The preparation consists first in soaking it for a night in warm or cold water to remove the excess of salt, and then rapidly drying it in a closed chamber heated by a coke fire in the centre. The windows are then opened and the bacon is exposed for some days to a current of fresh air. Some hams are hung subsequently in a dark room to obtain a blue mouldiness on the surface, or a "bloom," which enables them, it is said, to be sold as Cumberland hams. This process may give rise to serious nuisance if conducted in an improper place and without proper care to prevent nuisance. Dr. Spear mentioned to me an instance of this nuisance which came under his observation at South Shields. The process was conducted in a wholly unventilated cellar immediately beneath an inhabited room, the inhabitants of which complained bitterly of the offensive steam and animal effluvia which entered their room through the loosely boarded floor. The nuisance came under his notice in consequence of a death of a child from diphtheria in this room. The parents, although poor, were respectable people, had no acquaintance in the neighbourhood so far as Dr. Spear could ascertain, and the child had not been out of the house for some days before her illness. The house (a single room) was, he says, in a manner, isolated, was remarkably clean, and in no way exposed to drain or privy emanations, and the water supply was beyond suspicion. Dr. Taylor, the Deputy Medical Officer of Health for Liverpool, informs me that this trade has occasioned nuisance in Liverpool from the discharge of the warm washing-water into the drains, the effluvia rising up through the traps of neighbouring house drains and from the street gullies. Such a trade as this should only be conducted in such a way as to provide against the effluvia becoming a nuisance, or entering inhabited houses.

The Curing of Fish.

Establishments visited.

THE CURING OF FISH.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	—
Nov. 4, 1875	Cushaw - -	Bethnal Green.	
" " "	A colony of fish curers.	Faith Street, Bethnal Green.	
Dec. 11 "	Do. -	Gun Street and Martin Street, St. George, Southwark.	
May 30, 1876	Twemlow - -	Salford.	
Dec. 8 "	Butty - -	Hull.	
" " "	Rowntree - -	Do.	
" " "	Pickering - -	Do.	
" " "	Baynton - -	Do.	

Localities and size of establishments.

Fish curing is a trade largely carried on in some towns. In London there are complete colonies of fish curers in some of the small streets in Bethnal Green and St. George's, Southwark. In these latter places the trade is confined to the costermonger class of the population, who cure herrings, sprats, and haddocks, each in their due season, carrying on the work partly within their dwellings and partly in the small back yards adjoining their houses. The narrow yard space between the houses in one street and those in another parallel street forms, in some such instances, one elongated narrow space occupied by little curing or smoking houses, nearly every house yard being thus furnished with means for curing. In Hull, on the other hand, and in some other places as London, Bristol, &c., there are comparatively large establishments, in which a considerable capital has been sunk, devoted to this trade. So extensive is the trade in Hull that the Sanitary Authority has thought it expedient to frame byelaws for its regulation in such a way as to avoid nuisance.

General description of the trade.

Herrings and sprats arrive at curing establishments packed with salt in barrels. Haddocks are purchased fresh for curing.

With herrings and sprats the first process consists in washing off the loose salt and scales, which, when washed off, are, in large establishments, placed in a heap or tub in the yard to be sold as manure. They are then well washed a second time in a basket by rotating the basket in a tub of water. They are then strung upon sticks about four feet long placed on a frame in the yard to drain, and when drained are transferred to the drying-house to dry.

The process of "kippering" herrings consists first in careful washing; the fish are then split open, the roes taken out (and sometimes sent away for preservation by tinning), and the fish are soaked for about two hours in strong brine, washed again, drained, and then smoked in the drying-house.

In curing haddocks, the fish are split open and gutted and the heads are cut off; they are then washed and scrubbed with a brush, soaked for a sufficient time in brine, and then hung up in the drying-house.

These preliminary operations are sometimes carried on within dwelling-houses, but in large establishments in properly constructed rooms furnished with proper arrangements for washing and scrubbing ranged against the windows or along a side of the room. The refuse (heads and guts) is occasionally put in a heap in the roadway to be removed by the public scavenger, but mostly I have found it set aside in tubs or tanks for removal by persons who collect it for manufacture into manure.

Drying and smoking.

The drying or smoking is effected in erections provided for the purpose. Where the trade is carried on, as in Bethnal Green, by persons of the costermonger class, these erections are small, and rather than anything else resemble long cupboards about 10 feet to 12 feet high and about 4 feet square in their horizontal dimensions, constructed of brick below but of wood above, closed in with a door or sometimes only with some sacking, and having sufficient openings in the side or roof to allow the issue of superfluous smoke. In more important establishments, the drying-houses are constructed of brickwork entirely or only to the height of six or seven feet from the ground and the rest of wood. They rise to the height of 12 to 25 or 40 feet and are very capacious. At Cushaw's, in Peel Grove, Bethnal Green, each compartment of the drying-house will accommodate as many as 26 barrels of herrings of 600 to the barrel. The drying-houses have means afforded above for the issue of smoke, these means consisting either of louvres or of trap doors or glazed skylights. When it is desired merely to dry the fish, coke fires are introduced into the space below where the fish hang, but when it is desired to smoke the fish, wood or sawdust is burned. The wood used is either oak, beech, or horn beam, and the sawdust either oak or mahogany, a little deal sawdust being used (in some small establishments more than a little, I expect) to assist in obtaining a sufficient ignition. Until the fish is "skin dry" the means of ventilation near the roof are kept open, but when the surface of the fish is dry enough they are closed up. In some establishments where the ventilation provided is merely the spaces between the unpointed tiles of the roof, and in other establishments where other special means are provided, I am told that no alteration is made throughout the process. The practice in this respect, then, seems to vary in different establishments. Herrings put into the drying-house at 6 p.m. are ready to be taken out at midnight or at 1 a.m.

Source of effluvium-nuisances.

The nuisances which arise from fish curing establishments depend upon the offensive odour which may proceed from the undue retention of refuse, or from a filthy mode of conducting the business, or upon the issue of irritating wood smoke from the drying houses. Mr. Bately, the medical officer of health at Great Yarmouth, where fish curing is largely carried on, tells me that the only nuisances which arise there are similar to those from other trade premises where refuse and filth are allowed to accumulate, and that nuisance from the wood smoke is rarely complained of. The authorities there have not considered it requisite to make special byelaws for the regulation of the business; and at Hull, the byelaws enacted mainly provide for due cleanliness and speedy removal from the premises of refuse and garbage. In London the nuisance from the wood smoke has been complained of in Bethnal Green, but the Sanitary Authority there has not seen its way to any serious action in respect of it. Nevertheless, the pungent smoke must, to say the least, be annoying when it enters the windows of adjoining dwellings. Ill-conducted establishments, if they pollute the air with effluvia from decomposing fish refuse, must on general principles be held to be injurious to the health of persons much exposed to such effluvia.

Mode of preventing nuisances.

The obvious remedy against the first class of nuisances from fish curing lies in scrupulous cleanliness of all parts of the premises and of the vessels and plant used in conducting the business, and in proper disposal of the refuse and garbage. The yard and floors of all parts of the premises should be evenly paved and duly sloped to a properly constructed drain inlet. The inner walls should be periodically limewhited, and if splashed, as they are apt to be when the washing vessels are placed against them, these dirty parts should be scraped clean before limewhiting. But it would be still better if, in these parts, the wall were covered with a smooth impervious material such as cement or glazed tiles, so as to permit of the surface being duly washed at the end of each day's work. At the close of each day's work the whole floor, together with the tubs and other vessels used in the process, should be thoroughly scoured and cleansed. I have seen several kinds of paving in use in curing houses, but the best of all has been made of cement. Such a paving may be seen in use at Butty's establishment, in Hull, where the arrangements generally are very commendable and contrast favourably with those of some other establishments in the same street. Cleaning-up, however, ought not to be left altogether to the end of the day's work. A proprietor may very easily, if he pleases, make and enforce regulations for the workpeople, prohibiting the scattering of fish heads and guts upon the floor during their work. For the reception of such refuse proper vessels, made of some impervious material, should be provided; and, when they are full, closely fitting covers should be put on, and in this condition these offensive matters should be removed from the premises daily. The remedy against the smoke nuisance from the drying-houses is equally obvious. It consists in carrying up a shaft from the roof to such a height as that the smoke shall be discharged above the level of adjoining houses, and so arranged that this shall be the only means by which the smoke shall escape.

The Frying of Fish.

Establishments visited.

The Frying of Fish.

Establishments Visited.

Date.	Name.	Locality.
At various times - -	Various establishments -	London.

Description of the trade.

In very many parts of London, and in some large towns, fish is sold ready fried for the convenience of poor purchasers. The fish, mostly plaice, is fried upon the premises, and almost always in the open shop in which it is subsequently sold. The fat used in the frying is various, but I understand is mostly refined cotton-seed oil. The boiling of the oil, and the cooking of the fish in it, is carried on at all times of the day and evening. It is a petty trade, but, nevertheless, is a source of considerable nuisance in some neighbourhoods, the offensive smell of the oil boiling and fish frying spreading often, not only through the whole length of the street where the shop is situated, but sometimes into adjoining streets also. When the shop is situated in a street occupied by poor persons of the class who purchase such food, complaints of the smell are rarely, if ever, made; but passengers are annoyed by it, and so also are the tenants of houses of the better class who chance to reside in the neighbourhood. For it is not only in poor streets that such shops are to be found. There is, I believe, scarcely a health officer in London who has not at some time been called upon by the authority under which he acts to advise as to an appropriate remedy for this nuisance. The difficulty in dealing with it lies in this, that the pan or fixed shallow iron vessel in which the fish is fried by a fire beneath, must be always open to view, and to allow of the necessary manipulation. The ordinary remedy suggested and adopted in a great many places has been the provision of a hopper above the pan, which hopper

Extent and source of the nuisance.

Mode of prevention of the nuisance.

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is intended to catch the fumes as they arise, and to convey them by an opening above into some adjoining chimney. But for various reasons the remedy has not proved always very effectual; the faultiness partly consisting in the defective draught of the chimney, partly upon the hopper not being brought low enough or far enough forward over and in front of the pan, and partly depending on the fact that, the process being conducted in the open shop, the wind entering the shop, and draughts of air, interfere with the due operation of the hopper. A more effectual arrangement would be to conduct the operation in a closed outhouse, or other place where draughts of air could not so interfere, to bring the hopper well down and forward, and to close in the sides, having only the front part of the pan open for observation and necessary manipulation. The chimney of the fire should be so constructed as to obtain a good upward draught, and should be carried up above the roofs of adjoining houses.

TRADE OF A FELLMONGER.

ESTABLISHMENTS VISITED.

TRADE OF A FELLMONGER.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 22, 1875	Byford - -	Bermondsey.	
„ „ „	Johnson and Bolsher.	Do.	
Dec. 18 „	Tanner - -	Plymouth -	Leather dressing, tanning.
„ 22 „	Head - -	Stonehouse, near Plymouth.	Preparation of pelts for exportation to America, preparation of hake-liver oil.
Jan. 1, 1876	Nickols and Son -	Joppa, Leeds -	Leather dressing, tanning, glue making.
„ 19 „	Ball - -	Bristol.	
„ 20 „	Gunter - -	Do. - -	Leather dressing, parchment making.
April 1 „	Fitch - -	Melton Mowbray -	Leather dressing, tanning, glue making.
May 30 „	Hossell - -	Salford.	
Nov. 24 „	Winsor - -	Bermondsey -	Manufacture of skin mats.
„ „ „	Cordrey - -	Do.	
„ 28 „	Herron - -	Hereford. - -	Leather dressing.
Dec. 4 „	Fenton - -	Glasgow.	
„ 8 „	Foster - -	Little Driffield. -	Leather dressing, tanning, artificial manure making.
„ „ „	Nicholson -	Do. - -	Leather dressing, artificial manure making, manufacture of skin mats.

App. No. 6.

On Effluvium Nuisances, by Dr. Ballard.

General outline of the trade.

The legitimate and simple trade of a fellmonger consists in receiving the "skins" of sheep, and in preparing them for the use of the leather dresser. He takes off the wool, which, if sufficiently long, he sells to the woolstapler, and he limes the skins, preparatory to sending them to the leather-dresser. Some fellmongers also, at the proper season of the year, convert the best skins into skin mats.

Kinds of skins received and dealt with.

Two classes of sheep and lambs' skins, chiefly, are received by the fellmonger, viz., fresh English skins from the butcher, or intermediately from the skin market, and dry foreign skins which come to him closely packed in bales. These two classes of skins undergo at his hands somewhat different treatment. Some fellmongers receive both classes of skins, others confine their trade to one class only. A few foreign skins which arrive moist, salted and rolled up, are dealt with like English skins. The following are the processes to which the skins are subjected to prepare them for the use of the leather dresser:—

Mode of dealing with English skins.

1. *English Skins.*—1st. The first process consists in cleansing the skins from dirt and dung, blood, &c. They are beaten with a mallet to detach any firm masses of dirt, and are then soaked and washed in water. In some country places, where a stream of water runs through the premises, this washing is done in the stream, which is sometimes dammed up for the purpose. In Bermondsey, the skins are laid in a "poke" or tank, or pool of water having a shelving bottom. A workman, in high water-boots, stands in this and washes the dirt out of the skins, rubbing them and waving them about in the water. He then throws them on the stones at the brink of the pool to drain.

2nd. The second process is liming. When there is no wool on the skins worth preserving, the skins are laid in a pit containing milk of lime. But the usual practice now is to lay the skins wool downwards upon a bench and to lay on cream of lime with a brush upon the fleshy surface. When thus brushed over, the skins are folded lengthwise (the limed surface inwards).

3rd. The skins are then in the summer time hung up in the yard out of doors, or in the winter in a chamber a little warmed. This process serves to loosen the attachment of the wool, and when it is loose enough the skins go to the "pulling-house."

4th. The "pulling house" is arranged with bins for different kinds of wool, and in front of them the workmen sit, each taking upon his knees a skin, from which he pulls off the wool with his hands and throws it into the appropriate bin.

5th. The skin denuded of wool is then termed a "pelt," and it is thrown into a pit containing milk of lime, where it remains until it is ready to go to the leather-dresser.

6th. When about to be sent from the yard the pelts are taken out of the lime pit, and are laid in a heap in the yard, ready for carting away.

Mode of dealing with foreign skins.

2. *Foreign Skins.*—These undergo a somewhat different process.

1st. Being hard and dry they require to be softened, and for this purpose they are first laid in a tank or pool of water for a period varying up to 40 hours. At Head's yard, in Stonehouse, I saw them soaking in a tank above ground, through which a stream of water was made to flow constantly. At these works, I was told that they only require soaking about three hours.

2nd. The next process after the skins have been drained from the water is what is termed "burring," that is to say, removing from the wool the "burrs" (apparently the fruit of some plant) which stick in it. This is effected partly by the use of a machine, "burring machine," adapted for the purpose, and partly (or subsequently when necessary) by the hand-labour of women, who pick out the burrs.

3rd. Foreign skins are not limewhited, but the attachment of the wool is loosened by the process of "tainting." The damp skins are hung up in a chamber which is warmed in the winter either by a small coke stove or by a jet of steam thrown into it. In the summer time the warming is unnecessary. In this chamber slight superficial change of the nature of putrefaction takes place. As soon as it is found that the wool pulls off readily, the skins are removed. This is a delicate process and requires to be very carefully conducted and watched, since in hot weather a little over retention in the "tainting oven" renders the skin utterly worthless to the leather-dresser.

4th. The wool is then either pulled off or scraped off. When pulled off, the short wool which remains after pulling is scraped off.

The remainder of the process resembles that in use for English skins.

The fellmonger before sending away wool to the woolstapler dries it by placing it on racks in a chamber heated by coke fires or by hot air pipes, or hot air is driven by a fan through the wool laid upon a wire trellis work.

Manufacture of wool mats.

Skin Mats or Wool Mats are made from the best and most woolly of English skins. The selected skins, as soon as they are received, are stretched upon a frame resembling a parchment frame, and being laid upon a table, the fleshy side is rubbed over by the hand with a solution of salt and alum to preserve them, and they are then folded and hung up until it may be convenient to dress them. When they are to be dressed, they are again placed on a stretcher and the fleshy side is scraped and a layer of whitening and water is brushed over. The skin then passes into a warm chamber to dry. When the whitening has become saturated with fat from the skin, the skin is again scraped, and this process of whitening and scraping is repeated until grease ceases to exude. Salt and alum in solution together are then rubbed in until the skin is thoroughly tanned. The skin is then well washed with soap and warm water preparatory to bleaching or drying. Bleaching is performed by placing the skins, while damp from the washing, in a chamber in which sulphur is being burned. The final process consists in scraping with appropriate instruments the inner side of the skin to render it all supple and of uniform thickness.

Fellmongering, an offensive trade.

A fellmonger's yard is sometimes a source of nuisance to the immediate neighbourhood, especially to persons residing in houses immediately abutting on it. I am told that in Bermondsey, where fellmongers' yards abound, it is a rare thing for complaints to be made. This is certainly not because they are always conducted in the best manner, but probably, in part, because the inhabitants of the district live by this and associated trades, and are so much accustomed to the effluvia that they cease to notice them. But as a matter of fact serious complaints have been made, and in one instance to this Department. For the most part, however, it is in country places that the fellmongering processes are most complained of, for it is in and about country towns that the trade is carried on in the roughest manner, and with the least regard to tidiness and cleanliness; moreover, in the country, it is scarcely ever worth while to carry on the simple trade of a fellmonger, and the processes of leather-dressing are, either partially or fully, carried on in the same premises in conjunction with it.

Sources of effluvium nuisances.

The sources of nuisance from a fellmonger's yard may be any of the following; viz. :—

1st. The reception of raw skins from the skin market or from slaughter-houses, and their transference from the carts. When the skins are not absolutely fresh, short of such an amount of decomposition as would render them worthless to the leather-dresser, they may, especially in the summer time, have a strong and offensive odour.

2nd. The ammoniacal odour proceeding from a large number of lime-painted skins hanging up at one time in the yard.

3rd. The emptying and cleansing of the "poke" after it has been in use for a long time.—Dr. Parker, the late Medical Officer of Health for Bermondsey, tells me that he has found this the principal source of nuisance in fellmongers' yards.

4th. The waste lime taken from exhausted lime pits. This contains more or less wool and animal matter, and when retained on the premises in a heap is apt to emit a more or less strong ammoniacal odour.

5th. The general mixed offensive odour proceeding from a yard which is badly or imperfectly paved and drained and where due cleanliness is not observed.

6th. When the skins are washed in a flowing brook or stream or the liquid refuse of the yard is allowed to flow into the brook, this (which may be an offence under the Rivers Pollution Act) may become an offensive nuisance below the works, especially if a large trade be carried on, and when the lower water is disturbed and agitated, as for instance, by a water-wheel.

In Mr. T. W. Keate's evidence given before the Select Committee of the House of Commons on Noxious Businesses in 1873, he only alluded to the first and fifth of these sources of nuisance. His report to a committee of the Metropolitan Board of Works, which was laid by Mr. C. Legge before the Select Committee, contains (Q. 1863) the following " passage: There is in my opinion nothing inherent in this trade which " causes it to be a noxious trade, nor could any nuisance arise from it, if " it were always carried on with the care and cleanliness which are quite " within the reach of the manufacturer. The only danger of nuisance " would be from the reception of decomposed skins from the market or " from the butchers, or from allowing skins to lie and become decom- " posed in the yard; but from what I saw in the different yards, and " from what was stated to me, I conclude that such a state of things is " easily avoidable and could only arise from carelessness or neglect" In his personal evidence (Q. 745) he said, "If the trade is badly " carried on inconvenience may arise, as a matter of course; bad odours " may come from a place like that, but that is entirely the fault of the " persons who are carrying on the trade; there is nothing necessarily " arising in connection with the trade." This is nothing more than may be said of almost any offensive business, and so far I agree with him.

How far injurious to health.

I have not been able to ascertain from Dr. Parker, who has had a large experience of the trade in Bermondsey, nor from other medical men and medical officers of health in the country whom I have interrogated upon the subject, that any distinct ill effect upon the health of persons living in the immediate vicinity of fellmongers' yards has been observed by them. Nor have I been able to ascertain that septic diseases have been noticed to occur with exceptional frequency in their neighbourhood, or with such frequency as to attract a health officer's attention. Nevertheless, a filthily-kept fellmonger's yard in a populous neighbourhood occasioning, as it necessarily must, a septic condition of the atmosphere about the works, is calculated (on general principles already enunciated) to be injurious to the health of the population most exposed to its influence.

Modes of preventing nuisances.

The trade of a fellmonger is not necessarily a nuisance. At Nickols' premises at Joppa, Leeds, where a very large number of English skins are dealt with weekly, and at Plenty & Co.'s in Bristol, where an equally large trade is done in foreign skins, the processes are all carried on in the best manner, and so far as I could learn without occasioning the least suspicion of nuisance. But at both these premises all are carried on within closed buildings. Slightly offensive skins must at times be received at fellmongers' premises; they cannot always be expected to be as free from odour as they are when newly taken from the carcass: and this is especially the case when the skins come from a distance and have to pass through a sale yard before they reach the fellmongers. Both in respect of the first and second sources of nuisance, there arises an advantage when the processes are not carried on in an open yard, as they commonly are in Bermondsey, but in covered and close buildings; and as respects the first, particularly, it is worthy of practical consideration whether the offensiveness of the skins might not be lessened, without injuring them for the operations of the fellmonger, by the application of some antiseptic, such as carbolic acid solution, to the fleshy surfaces before their removal to the yard. As regards the third source of nuisance, it does not appear from what I have observed of the mode in which the process is conducted in various works I have visited, that it is at all a necessity to use the same water in the poke repeatedly day after day for a lengthened period. It should be changed once a day at least, and in the summer time, twice a day. In some country towns I have seen running water used for soaking and washing English skins. I may instance Ball's yard in Bristol, where the Malagold stream is used for washing the skins; and Nickols' premises in Leeds where the water which runs through the washing tanks is pumped up constantly for the purpose. At Head's yard in Stonehouse the tanks for soaking and cleansing foreign skins are supplied with a constant stream of fresh water. The cost of water for the poke if obtained from a town supply by meter, may be in some cases a sufficient inducement to neglect daily cleansing of the poke and daily renewal of the water. The obvious remedy for the fourth source of nuisance is the emptying the waste lime at once into covered carts for removal. The remedy for the fifth source of nuisance is equally obvious. It consists in good impervious paving properly sloped in all parts of the premises, good drainage and scrupulous cleanliness. The yard should be kept constantly swept up, and the interior of the buildings and walls should be periodically limewhited. Unfortunately the traditions of the trade do not favour such scrupulousness. The trade is rather regarded as an essentially dirty one, and little pains are usually taken to make it otherwise. However, to those who may wish to see what good arrangements may effect for the prevention of nuisance, I recommend a visit to the two model establishments already mentioned. The sixth source of nuisance is to be obviated by intercepting the liquid refuse and by using one of the known methods of purifying sewage before it is allowed to flow into the stream or into a town sewer communicating directly with the stream.

LEATHER-DRESSING AND PARCHMENT MAKING.

LEATHER-DRESSING AND PARCHMENT MAKING.

ESTABLISHMENTS VISITED.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 9, 1875	Bevington and Son	Bermondsey.	
„ 18 „	Tanner - -	Plymouth -	Fellmongering, tanning.
„ 22 „	Head - -	Stonehouse, Plymouth.	Fellmongering, hake-liver oil making.
Jan. 19, 1876	Plenty & Co. -	Bristol.	
„ 20 „	Gunter - -	Do. - -	Fellmongering.
April 26 „	Turney Bros. -	Nottingham.	
May 30 „	Hossell - -	Salford - -	Do.
June 1 „	Nickols and Son -	Joppa, Leeds -	Fellmongering, tanning, glue-making.
„ 2 „	Clark and Thackray.	Newlay - -	(Calf skins), glue-making.
Nov. 24 „	Beach and Son -	Bermondsey -	Manufacture of skin mats
„ „ „	Godman - -	Do. - -	(Calf skins).
„ „ „	Joseph Sharpe and Sons.	Do. - -	(Seal and horse skins).
„ „ „	James Garnier -	Do.	
„ 28 „	Herron - -	Hereford - -	Fellmongering.
Dec. 8 „	Foster - -	Little Driffield -	Fellmongering, tanning, artificial manure making.
„ „ „	Nicholson -	Do. - -	Fellmongering, artificial manure making, flesh and bone boiling.
„ 20 „	Turney Bros. -	Stourbridge -	Chamois leather making.
Mar. 14, 1877	Evans - -	Sowston, Cambridge.	(Chamois leather), fellmongering.
April 24 „	McRae - -	Mitcham - -	(Chamois leather and buff leather.)

Definition of the trade.

In Bermondsey a distinction is drawn between a tanner and a leather-dresser. The former receives raw bullock "hides" and prepares and tans them; the legitimate trade of the latter is to receive "pelts" (sheep skins deprived of wool and limed) from the fellmonger, as well as horse skins, seal skins, calf and goat skins, and to convert them by a process of "tanning" or "tawing" into light leather. In country towns it is not unusual to see tanning and leather-dressing conjoined and carried on in the same premises; and then the manufacturer is generally designated and calls himself a "tanner." Under similar circumstances fellmongering is often also conjoined, so that the leather-dresser prepares his own pelts. The division of labour which is observed in Bermondsey is, for the most part, only practicable in large towns. When a leather dresser, besides receiving "pelts," also receives calf skins, horse skins, and goat and seal skins (as is sometimes the case), the first part of the process, that is the liming and scraping off the hair, resembles in most respects the similar process to which sheep skins are subjected at a fellmonger's yard. Hence in describing the trade of a leather-dresser I shall confine myself to the part of the process which commences with the reception of the "pelts."

Process of leather-dressing.

They are first placed upon a curved board or "beam," where a man standing behind the beam scrapes them down on the fleshy side with a curved knife with two handles, so as to remove the connective tissue. This process is termed "breaking," and the parts removed are called "fleshings." At some works (as at Herron's in Hereford) a machine is used to perform this part of the work.

They then go back into pits containing milk of lime, first into lime pits previously used and hence weak, and then into newer lime pits which act more powerfully on the skins. The liming is continued altogether for 18 or 20 days.

The next process is to wash out the lime. This is usually done by putting the pelts into a tank of fresh water, where they are kept moving by beating the water by means of a sort of paddle-wheel, or else by putting them with water into a large revolving barrel having boards so placed within as to throw the skins over and tumble them about.

After having been well washed they are usually put into a solution of what is called "pure" (more correctly, it is said, spelt 'puer'). This is dogs' dung, either collected by poor people in the streets for sale to leather-dressers, or more commonly collected at large kennels and sent to the leather-dressers in barrels. It is, when received from the kennels, a pultaceous looking material and stinks abominably. In large establishments it is emptied into a covered tank underground, whence it is pumped up as required. When about to be used, a quantity, which varies in different establishments, is added to water in a tub or tank. Sometimes, as in the summer, it is sufficient to use cold water; but in the winter it is usual to employ the solution warm, *e.g.*, at a temperature of about 80° to 120°. Before putting the pelts into the puer tub they are commonly washed in some warm water. They remain in the puer solution until, from having a gristly feel between the fingers, they feel soft and supple. The time given for this varies in different works, with the temperature of the solution and with its strength, from 10 or 20 minutes to two or three hours, or even longer. Each manufacturer has his own peculiar practice in this respect. All, however, take care to remove the pelts as soon as the desired result is obtained; since, if they remain longer in the "puer," they are rotted and become worthless.

On removal from the puer tub they are again scraped down or "scudded," then washed in some warm water, and after this put into a tub containing bran and water. This is called a "drench." Here they remain about 48 hours; the contents of the tub undergo some fermentation, and the pelts come out whiter than when they were put in. At some works I have been informed that no puer is used; nothing but drenches.

English skins contain, especially about the neck and shoulders, a quantity of fat which, if left there, would interfere with the colour of the leather after tanning, so that it has to be removed. Sometimes this is done by cutting or slicing it off with a sharp double-handled knife, but sometimes, after "puring," by subjecting the pelts to pressure in a hydraulic press. The fat runs out and is collected in a reservoir below for use by soap-boilers and others. Another method consists in subjecting the pelts to a scrubbing process by a machine patented by Mr. Turney of Nottingham. The pelts are now ready for tawing or tanning, or to be prepared for exportation in barrels to America.

To prepare pelts for the American trade, they are next treated with dilute sulphuric acid, and subsequently with strong brine. After soaking for about 10 minutes in the acid they appear blown out and thickened, and the fibre of the pelts looks porous. But after having subsequently lain a few minutes in the brine they resume their former appearance. The pelts are then rolled up and packed in barrels with salt.

For "tawing" the prepared pelts are treated in a tumbler-barrel with salt, alum, yolk of egg and water.

Tanning is usually effected by soaking in a bath of sumach or other tanning liquor, the precise method of applying these liquors varying in different establishments.

Sometimes skins are split by a machine which, while fixing the skin and pushing it onwards, cuts the skin with a knife into two layers. None of the other processes require any description here. They consist in drying, rolling, dyeing, &c. &c.

The "fleshings," &c. from the skins usually go to the glue-maker, but in some works are made into manure either on the premises (as near Driffield) or elsewhere. At Henry Turney's works in Stourbridge they are steamed in an open tank and subsequently pressed for the extraction of grease before being sent away for manure making.

Degree of nuisance arising from it.

The offensive smells that proceed from leather-dressers' establishments are rarely very serious, and they do not appear usually to extend to any considerable distance. Immediate neighbours, if there are any inhabited houses close to a yard, and passers by in the street, are alone likely to be offended by them for the most part. But I met with one instance of a very badly-conducted establishment where the nuisance was very great, and had been intolerable; a highly-offensive smell from the works having been a source of serious nuisance at a distance of a quarter of a mile.

To what extent injurious to health.

I have not heard at any time of any injury to health that has been occasioned, other than sometimes such temporary disturbances as any offensive smell may produce. In the instance above referred to, the effluvia gave rise to loss of appetite, nausea, and severe vomiting. I have failed to obtain satisfactory proof of septic diseases being more prevalent in the vicinity of such works than elsewhere. Yet, on general principles, an atmosphere loaded with septic pollutions from such works when ill conducted, must be held to be unwholesome.

Nuisance may arise from the following sources, viz.:—

Sources of effluvium nuisances.

1. The "puring," if it be conducted in a part of the premises close to a public way or to inhabited houses, and then chiefly, if not solely, when, as in the winter, the solution is used warm. Under such circumstances the vapour which rises from the puer tub is exceedingly offensive and disgusting. It pervades the chamber or building in which this part of the process is conducted to such an extent that I myself have been very glad to make my escape; and it passes out of the building by the windows or louvre openings.

2. The discharge of the used up puer solution, drenches and other offensive liquids into the drains may also be offensive, if any open or imperfectly trapped inlets are in the vicinity. Their discharge into a flowing stream may cause more or less nuisance down the stream.

3. If the premises be uncleansed, badly paved and drained, and the business be conducted, as it too often is, in a slovenly manner, a generally diffused offensive smell is apt to pervade them, and to be wafted by the wind to houses and places in the neighbourhood.

In addition to these sources of nuisance, offensive effluvia may arise from other processes, such as manure making, carried on conjointly with leather dressing. I found this to be the case with some small establishments near Driffield.

Mode of preventing nuisances.

The remedies for these several sources of nuisance are as follows:—

1. Various attempts have been made to find a substitute for "puer" for softening pelts, but hitherto without success, or with only modified success. No leather-dresser, I am told, could undertake to produce a good specimen of leather without it. Nevertheless, several persons in a large way of business have told me that they have of late reduced its consumption considerably, and that by the judicious use of drenches much may be effected in this direction. If it be the case (as it seems, from what I have noticed, to be) that a cold solution produces the same effect as a warm solution, with the single disadvantage of a rather longer soaking in it being requisite, one source of nuisance might be in

a great measure done away with. At Henry Turney's works, at Stourbridge, where the puring shop adjoins a public way, the nuisance is avoided by the closure of all windows on that side of the shop, and by carrying a wooden shaft 2 feet square from the ceiling of the puring shop, through all the upper rooms, to above the roof of the building.

2. The second source of nuisance is not usually a very serious one, and may be obviated by the addition of one of the well-known deodorants before the discharge of the waste liquors. At Herron's works in Hereford, where much nuisance arose from pollution of the stream with waste liquors discharged into it, these liquors are now collected, allowed to subside in a tank, and then purified with lime before being discharged.

3. As respects the third source of nuisance everything depends upon the general management of the yard and premises. As generally conducted, leather dressing is a very dirty trade; but there is no reason whatever why it should in any case be carried on in a dirty manner, so as to be a cause of offence to neighbours. Good and appropriate paving, (wood, being absorbent, is especially to be avoided) good drainage, the speedy removal from the premises of fleshings, and other refuse scraped from the pelts, and of the refuse lime from the pits, together with general cleanliness and avoidance of litter, and periodical scraping and lime-whiting of the interior of the buildings, would effect all that is necessary to render many of the premises, now a source of nuisance, sweet and inoffensive. With a view to show what can be done by careful arrangement in such matters when the proprietor sets his heart upon it, I append a description of a model leather-dressing establishment at Nottingham, belonging to Turney Bros., merely premising that I describe it as it was in the middle of the day when I visited it, without a word of intimation of my visit having previously been given. The tidiness of the establishment, in those parts where the dirtiest portions of the trade are carried on, contrasts in a very marked manner indeed with what is to be seen in the majority of leather-dressers' works. The trade here was commenced in a very small way only 15 years ago, and the buildings have been extended and added to, from time to time, as the trade grew. Only English pelts are received, and now, of such, an average of 18,000 are dealt with per week, 200 hands being employed at the works. The buildings are well built in brick, and on the four sides of a large quadrangular yard, which is well and firmly laid with square stone sets, and so sloped that water is readily carried off the surface. It was scrupulously clean, and there were no bits of skin or fleshings lying about it to render it untidy. Some fleshings prepared for removal were tidily laid in a heap. As Mr. Turney was crossing the yard with me he espied a little scrap or cutting of skin lying on the pavement, and (evidently automatically) he picked it up and threw it on the heap—a trifling incident this, but one that speaks volumes. The whole of the processes are carried on within the buildings, in spacious well-lighted rooms. The ground floors of the buildings are devoted to the wet parts of the trade, and to the engine-room, and the upper floors to the dry parts, and as store-rooms. All the ground floor rooms (with a trifling partial exception) are closely laid with blue bricks in cement upon a firm bottom of 6 inches of concrete also made with cement in place of the ordinary lime. The floors are duly sloped for the effectual running off of any surface water, and are thus absolutely free from all sloppiness, and there are good drainage arrangements in every part beneath the surface. The supply of water is abundant, and there is no stint in its use. The pits in the room devoted to liming and washing the pelts are arranged down the sides, so as to leave a wide clear

Description of a model establishment.

passage between them. They are constructed in blue or red bricks (the latter only where the pits are circular), and these are laid with cement. In any case the edges of the pits are constructed with hard blue bricks so as to obviate the effects of wear and tear as far as possible, and to conduce to tidiness and cleanliness. The fleshing-shop is a long room on the opposite side of the quadrangle, having the splitting-room at right angles with it at its further end. Along each side of the central passage of the fleshing-shop is a slightly raised platform paved with stone, and on this the beams stand at which all the "fleshing" or "breaking" processes are performed. Between this raised platform and the wall there is again the usual paving of blue bricks, on which all matters scraped off the pelts fall, and remain until removed. Every part of the interior of the walls and ceiling of this room was clean and lime-whited. Some of the peculiar odour of "puer" was noticeable in the puring-shop, but it was not intolerable, and was imperceptible outside the open door. The puer tubs and the apparatus in the room were scrupulously clean, as well on the outside as within, and the floor (partly boarded) and pavement were clean and free from any dirty slop. Necessarily they were wet, but it was with water, for the running off of which good facilities are provided. What struck my attention most forcibly in these works was the perfect cleanliness, tidiness, and order which pervaded them throughout. Mr. Turney told me that they had no fixed time for cleaning up. It is always going on in all parts of the building. I noticed this even in the upper stories and in the store-rooms. He says that if any dust is made in moving goods about, the man or woman who makes it is bound at once to sweep it up. He believes this cleanliness alone costs him as much as 2*l.* per week. The fleshing-shop is thoroughly swept up every day, the workmen taking this duty in turns. The splashed walls opposite the beams (in most works I have seen, deeply encrusted with filth), are scraped three or four times a year, and every part of the interior of the buildings is lime-whited twice a year. The puring-shop is thoroughly cleaned every night, and once a week the puer tubs are scrubbed inside and out, and all the other apparatus in the room similarly thoroughly cleaned. He avoids litter very much by having had tramways laid down from one part of the ground floor of the building to another, along which the goods and refuse are conveyed in a trolly drawn by a donkey. When I asked him how he got his workmen to preserve such an unusual amount of cleanliness, he replied that it was a rule of the establishment, that the men had to subscribe a set of stringent rules on entering his service, and that they knew that, under them, an infringement was punished by immediate dismissal. He has thus the command of the best workmen, and even men from slovenly works speedily fall into the habits of tidiness which they see established here. With the permission of Mr. Turney I had photographs taken of the courtyard of the works, and of those parts of the premises in which the wet and usually dirty processes are conducted. I append these photographs to my report. They were taken under my own supervision, and represent correctly the condition in which I found the premises: a condition of tidiness and cleanliness which contrasts strongly with what is usually observable on the premises of leather-dressers.

Nickols & Son's establishment at Joppa, Leeds, shows the nearest approach of any works I have yet seen to the model works of Messrs. Turney. Both are well worthy of a visit.

Manufacture of chamois leather;

The manufacture of "*chamois leather*" presents peculiarities which call for its special description. The following is the process as I saw it

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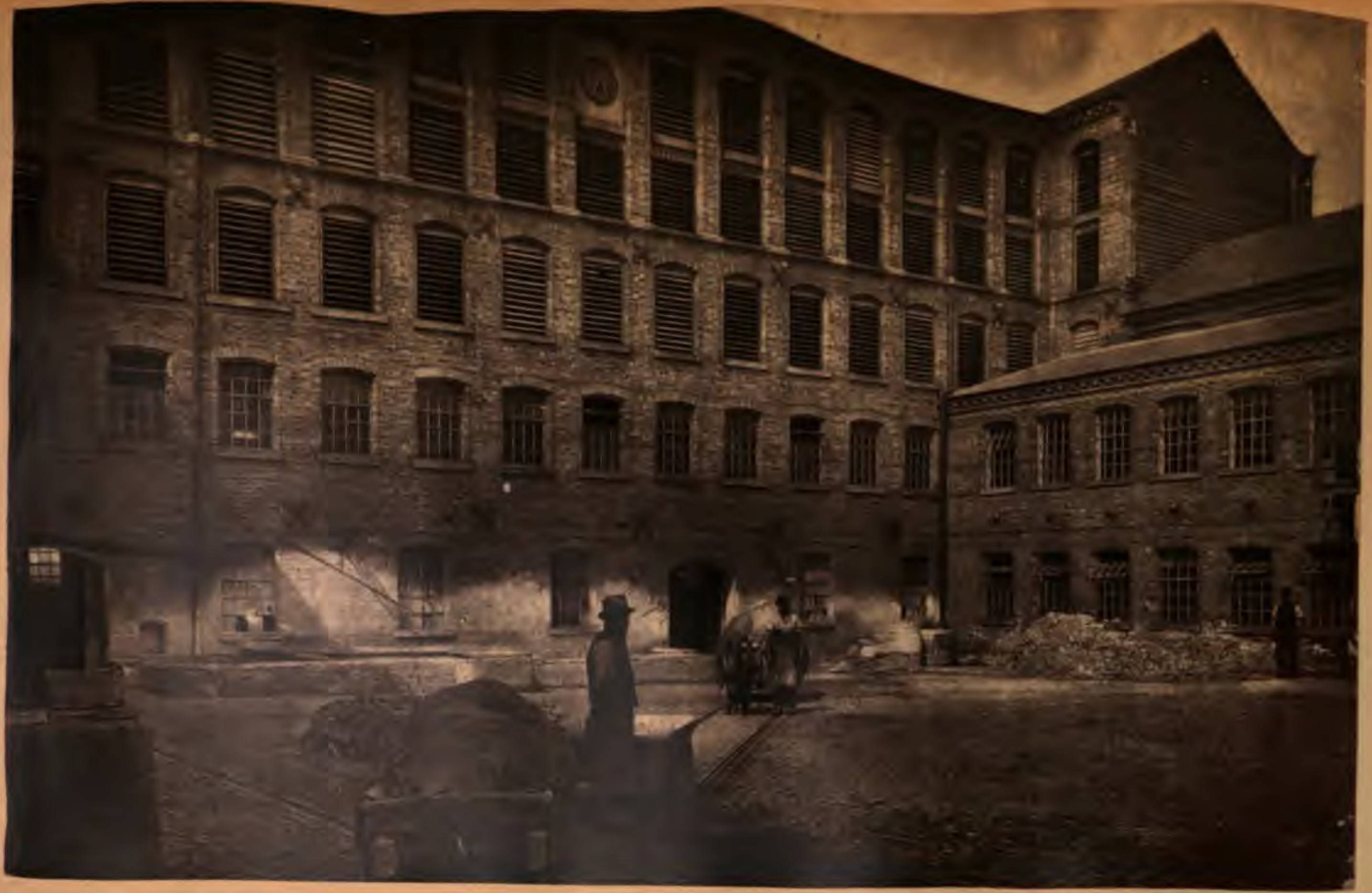

COURT-YARD AND TRAMWAY.

PELTS IN PASSAGE FROM "LIMING-SHOP" TO "FLESHING-SHOP." "FLESHINGS" AS DEPOSITED FOR REMOVAL.

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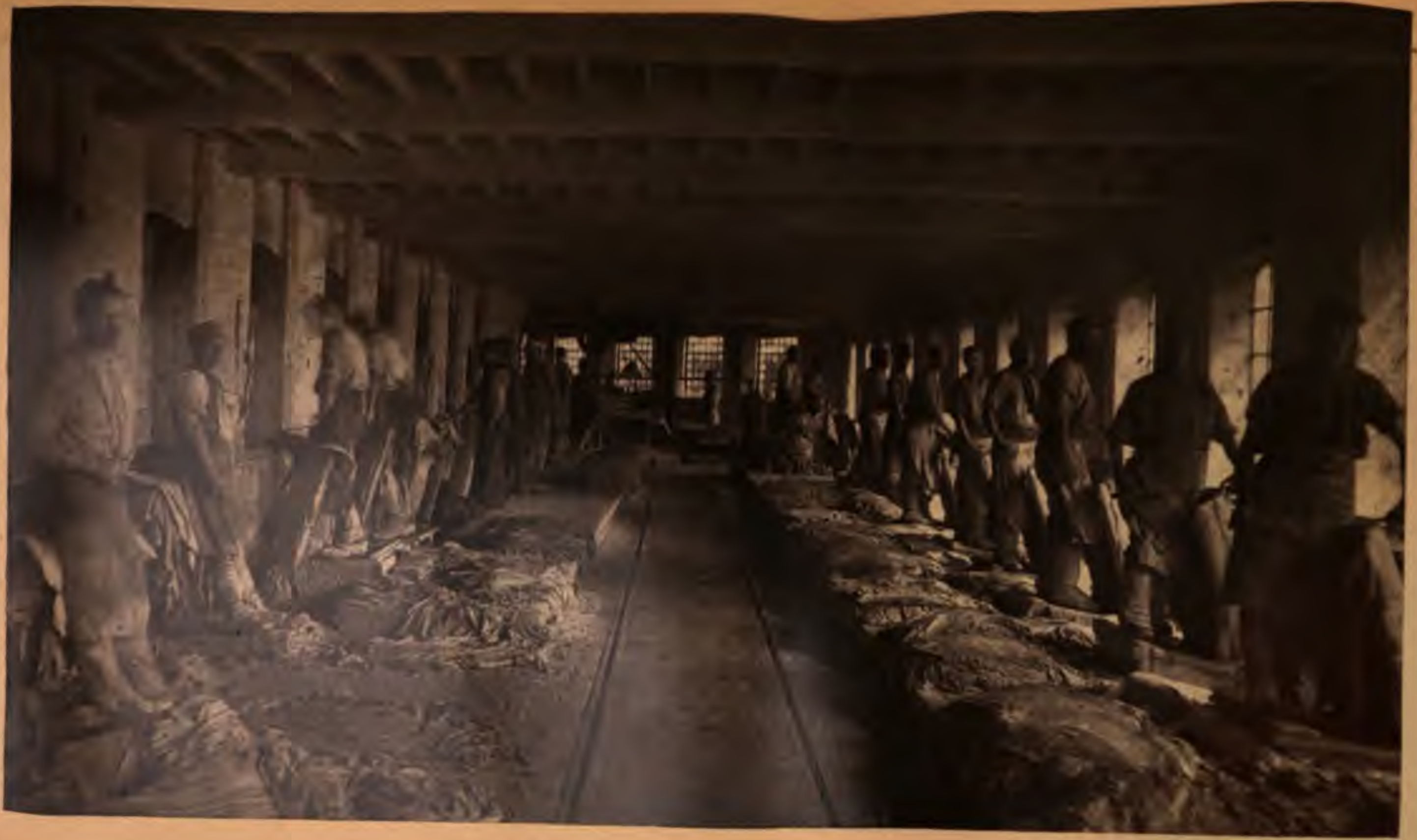

"FLESHING" OR "BREAKING" SHOP.

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“PURING” SHOP.

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Special process.

carried on at Henry Turney's, in Stourbridge. After the "pelts" have been fleshed and split, the inner or flesh-sides are taken for the manufacture. This portion is again passed through the splitting-machine in order to take off from the thicker parts so much as may suffice to render the skin of uniform thickness throughout. It is again limed, then washed, and afterwards put into a bran-drench. After removal from the drench the skins are pressed nearly dry and then removed in bulk to the stocks, where they are beaten until they are soft with heavy tilt-hammers. When soft, oil (cod-liver oil in preference) is sprinkled on them and the "stocking" is continued, oil being added from time to time. The skins are then taken out and "aired off," *i.e.*, hung up in the room to dry. At other works, where there is a sufficient open space adjoining, the skins are in dry weather hung out in the open air. This "stocking" and "airing-off" are twice repeated, and the skins are then hung up in a chamber heated to about 120° by hot-air or steam pipes. An offensive vapour of acrolein* becomes thus diffused in the chamber. When the skins are dry they are "stocked" with oil again, and the beating is continued until the mass of skins becomes hot. They are then taken out and packed into a cask covered over with blankets and left to "ferment." The contents of the cask become very hot and an abundance of vapour of acrolein is given off. After the fermentation has continued for a time the skins are turned over and transferred to another cask. During this process acrolein vapour is largely evolved and affects very greatly the eyes of the workmen. The fermentation is continued now until heat ceases to be generated, and then the skins are allowed to get cold. The next thing is to get the oil out. With this object the skins are now thrown into hot water and from thence transferred to a powerful press. After leaving the press they are put into a "tumbler," or revolving barrel, with warm water and soda ash, and subsequently washed with cold water. Lastly, they are passed between rollers to press out all remnants of moisture and soapy matters and hung up in a loft to dry. The further processes have no interest in relation to this Report; they consist of various manipulations of scraping, pulling, stretching, &c., for the preparation of a saleable article. The oil pressed out of the fermented skins is known as "sod-oil." Before leaving the premises, it is customary to boil it in a pan heated by close steam in order to drive off any water it may contain. It is then sent away for use by curriers.

Special source of effluvium-nuisance.

The only special nuisance likely to arise in these proceedings would arise out of the diffusion of acrolein vapour beyond the works. Mr. Turney's works are so situated and arranged, however, as not to occasion any offence of the kind. But Dr. C. Fox, the Medical Officer of Health for Chelmsford rural district, informs me that the peculiar odour of fish oil and acrolein proceeding from some works in his district, which I was not permitted to inspect, is a nuisance at a distance of over 400 yards, when the wind is in a direction to carry the effluvia towards the public roadway. An effectual remedy for such a nuisance would probably be found in performing all the oily parts of the business within closed chambers from which the offensive vapour might be drawn off and conducted through a fire before being allowed to issue externally.

Parchment-making.

In making *parchment*, the pelts, after liming and washing and fleshing as for leather-dressing, are split by the splitting machine, and the inner layer is taken for the making of the parchment. Knots are made in the edges of this layer by tying up portions of lime or rubbish into balls all round, and by these knots the skin is stretched upon wooden frames. While on the frames the split side is scraped to render it even, and the skin is then "dubbed" with whitening and a strong solution of soda ash to get out the grease, and then it undergoes a series of scaldings with hot water thrown upon it out of a bowl, of scrapings, and of washings with whitening and water, and it is finally dried in a warm chamber. The sources of nuisance from such works are similar to those arising from leather-dressing, except the "puring" nuisance. Good drainage and cleanliness are very essential.

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* The odour of acrolein may be familiarly illustrated by comparing it with that given off from an imperfectly extinguished oil-lamp.

Tanning.—Preparation of "Pickers" Hides.

TANNING.—PREPARATION OF "PICKERS" HIDES.

ESTABLISHMENTS VISITED.

Establishments visited.

Date	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 9, 1875	James Barber Bros.	Bermondsey.	
„ 18 „	Ward Bros.	Plymouth.	
„ „ „	Tanner	Do.	Fellmongering, leather dressing.
Jan. 19, 1876	Perry and Evans	Bedminster, Bristol.	
„ „ „	Cox Bros.	Do.	
„ „ „	Cox and Shepperton.	Do.	
„ „ „	Rake & Co.	Do.	
„ „ „	Drake and Son	Do.	
„ „ „	Vickary Bros.	Do.	
„ 20 „	Cogan	Bristol.	
Feb. 2 „	Reynolds	Warrington.	
„ „ „	Tinsley	Do.	
May 30 „	Butterworth	Salford.	
June 1 „	Nickols and Son	Joppa, Leeds	Fellmongering, leather dressing, glue-making.
„ 8 „	Philbrick	Reading.	
„ 16 „	Ashworth and Percival.	Broughton, Manchester.	(Pickers hides).
„ „ „	Marsden and Wilkinson.	Do.	(Do.)
Nov. 24 „	Cox	Bermondsey.	
„ „ „	Ellis	Do.	Felt making.
„ „ „	S. Barrow	Do.	
Dec. 8 „	Foster	Little Driffield	Fellmongering, leather dressing, artificial manure making.

Definition of the trade.

The legitimate trade of a "tanner" is the conversion of bullocks' "hides" into leather.

Kinds of hides used.

Three classes of hides are in use:—1. Fresh English hides from the butchers or the hide market, which are known in the trade as "market hides"; 2. "Salted hides," mostly from South America, but also from other places; and, 3. Dried hides, either sun-dried, or dry-salted. They come from India, the Cape, South America, &c. They are known in the trade as "kips."

Some tanners receive two or more of these classes of hides, but the best tanners limit themselves to one class only.

Process of tanning.

In describing the process to which hides are subjected by the tanner, it will conduce to clearness to describe the process of tanning "market hides," and then to state the variations in treatment considered necessary in the case of the other two classes.

1. Of market hides.

1. *Market Hides.* 1st. The first process is "liming." A tanner has in his yard a series (or more than one series, according to the extent of his trade) of lime pits, which are worked in "shifts." They are usually series of three, the first being an old pit, the last being a pit of newly made milk of lime, and there is one intermediate. The hides to be limed are first laid one above another in the oldest of the three pits. It is called in the trade "backward lime," and is therefore the weakest (or the least caustic) of the shifts. Here they remain about two days. They are then removed into the intermediate pit, where they remain about three days; and then into the fresh lime, where they remain another three days at least. Some tanners prolong the liming process considerably beyond this period. The milk of lime is made with 6 to 10 bushels of lime to the pit. During this process the hides are "hauled" daily. This "hauling" consists in two men drawing out each hide separately with hooked instruments, and laying the hides one upon another at the edge of the pit, and then putting them back again. This is done to secure an even action of the lime. The exhausted lime-pit is then emptied, the water being run or pumped out, and the deposit laid in a heap in the yard until it can be taken away.

2nd. The next process is the removal of the hair. This is called "unhairing." Some tanners first draw the hides through fresh water, to prevent injury to the workmen's hands. Each hide is placed, fleshy side downwards, upon a semicircular iron beam, behind which the workman stands and scrapes downwards with a double-handled curved instrument called an "unhairer."

3rd. The hides are then washed in clean water and "fleshed," that is to say, the loose inner tissue is sliced off with a very sharp curved knife, the hides being placed on the same sort of beam as in previous process. The matters sliced off are called "fleshings," and are sent to the glue makers.

4th. The hide is then laid upon a table or bench and "rounded," *i.e.*, the shoulders and bellies are cut off to be separately dealt with, and the corners are removed, the small scraps leaving the premises for use by the glue-makers. The hide after this treatment is henceforward known as a "butt."

5th. The "butts" are put into clean water for a few hours to clean off some of the lime, and then, if it is intended to "dress" them subsequently, that is to convert them into "uppers" or soft leather, into the "graining" pit. This is a pit containing a solution of pigeon's dung, called "grainers." This tends to soften the material, as "puer" to soften sheeps' pelts. Sometimes water mixed with urine is used for the same purpose, or a weak solution of ammonia, and sometimes fowls' dung is used in place of pigeons' dung. The "grainers" are used cold.

6th. "Scudding" is the next process. The hides are replaced on the beam, and are worked over with a double-handled instrument like an "unhairer," so as to remove all superfluous water and dirt, and the small hairs are removed by skimming over the surface with a sharp knife used like a razor.

7th. Such hides as are to be split now undergo the process in splitting machines.

8th. The strictly tanning process is then proceeded with. The first part is called "colouring." For this purpose the butts are suspended upon poles by a hole made through the neck part, and are lowered into a pit or washer of old tan-liquor. They are raised and lowered again several times daily for about eight days. I have seen this process performed by causing the butts or kips to revolve in a barrel having holes in it, in a tank of old tan liquor; the interior of the barrel being so arranged as to cause the contents to tumble over. The object is to colour evenly in all parts. The butts are then taken off the poles and go into the tan-pits. These are worked in "shifts;" they are known as "floaters" and "dusters." First they go into, say, four floaters in succession, which are pits of tan liquor of gradually increasing strength, and, after passing through these, being "handled" (that is to say, taken out and laid in again) about twice a week, they are removed to the "dusters." "Dusting" consists in laying the butts in liquor of the strength of about 25 degrees of the "barkometer," sprinkling some crushed bark over each of them, each pack being usually put into three or four such new liquors and remaining in each liquor for a week without being touched. They are then "laid away in layers," that is, they are put into pits of liquor of 30 to 50 degrees strength, dusting them as they are laid in. The strength of the liquor is gradually increased as they are passed from one pit to another. In each of these pits they remain about a month. The whole process of tanning occupies about 10 months, but it is said that in some yards it is performed much more speedily. Tanners who follow the old process, however, say that thorough tanning cannot be executed by this speedy method. The materials used in tanning are oak-bark, mimosa-bark, valonia, and sometimes terra Japonica, or various imported extracts such as hemlock, chesnut, &c.; but the old tanners will not use some of these latter articles.

2. Of salted hides.

2. "*Salted Hides.*"—These are treated in the same way as "market hides," except that they are usually first soaked for a day or two before liming to get rid of the salt.

3. Of 'kips."

3. "*Kips.*"—These come to the tanner in bales and as hard as a board. Before being dealt with, therefore, they must be softened. For this purpose they are put into pits of water called "soaks," where they remain until they are sufficiently softened to allow of further manipulation. Nearly all the kip tanners I have spoken with tell me that they prefer to use "old soaks;" that is to say, the same water is used without renewal over and over again for successive lots of kips. Fresh water, however, is added when necessary.

They then go to be "stocked," that is to say, the hides are beaten with heavy hammers like cloth stocks while a spray of water plays over them. I met in the course of my inquiry in Bermondsey with one kip tanner who did not "stock" his kips. The manager told me that, in consequence of this, they could not dispense with old soaks, and that they used a "shift" of four soaks of various ages, from fresh water to soaks of three weeks old. The hides had to remain in these until they were soft.

From the stocks they go to the lime pits, but, being of thinner texture than English hides, weaker lime is used. The remaining process is similar to that for market hides, only that it is not the practice to "round" them, and that they are not "dusted" or "laid away" but worked round shifts of clear liquor. They require frequent moving to ensure softness.

In many yards most of these processes are performed in the open air or under open sheds: in the best and newest yards, however, entirely under cover, or in closed buildings, as at Nickols' at Joppa, Leeds. A great deal of slopping too is unavoidable, not only in the liming and other preparatory processes, but in the tanning also. This arises out of the necessity for frequent "handling." The tan liquors are pumped, however, from one pit to another as required.

The remaining processes of drying, &c. require no notice in this Report.

App. No. 6.

On Effluvium-Nuisances, by Dr. Ballard.

Kind of tanneries chiefly complained of.

I need not refer to the position of the tanneries in Bermondsey, situated, as they are known to be, in a densely populated district. In towns I find them usually at the outskirts or in the suburbs, and, as at Leeds and Bristol, in neighbourhoods which, like Bermondsey, appear very much devoted to this trade. But in some towns I have met with them in or near the centre of the town, where, if ill conducted, they sometimes create considerable nuisance. Old tanneries, and especially "kip" tanneries, are those which are mostly complained of, when I have heard of complaints of nuisance. The newer establishments, roomy, arranged upon modern principles, and with all the modern appliances for conducting such a dirty trade in the best way, are usually no cause of nuisance at all. I met with a striking instance of this contrast at Warrington, where, about four years ago, a tannery at the end of Mersey Street, conducted by Mr. Reynolds, was a very considerable nuisance, and was very offensive to passers by. On visiting Warrington last year, missing the offensive smell, I asked the inspector of nuisances who was with me what had become of the tannery, and he showed me on the same site a new block of buildings greatly extended. The old works had been done away with, and all had been transformed.

To what extent injurious to health.

From the numerous inquiries I have made I have been unable to ascertain that any special unhealthiness prevails in the neighbourhood of these offensive tanneries, but instances have been adduced where the offensiveness has been such as to cause loss of appetite, nausea, &c. in persons residing near them. At the same time such works, if badly conducted, may occasion about them a condition of atmospheric pollution with septic effluvia which, on the general principles enunciated in the preliminary part of this Report, must be held to be injurious to health.

Sources of effluvium nuisances.

The ordinary sources of offensive smells in connexion with tanneries are one or more of the following, viz.:—

1st. The passage through public thoroughfares and reception and unloading of offensive hides, mostly, perhaps, imperfectly cured foreign hides. The office papers relating to St. Olave's, Southwark, contain the particulars of serious nuisances referable to this source.

2nd. The offensive smell proceeding from the disturbance of the old soaks in "kip" yards, when the hides are removed from them, and also when the old soaks are emptied and cleansed. The water of an old soak becomes putrid, and the deposit is horribly offensive. The cleansing of an old soak on his premises is stated to me by Mr. Nickols of Leeds to have produced, on one occasion, very dangerous effects upon the men engaged in the work. Dr. Parker, the late medical officer of health for Bermondsey, tells me that, in that district, the principal nuisance of tanneries arises from the old soaks.

3rd. The hauling of the hides at the lime pits is a constant source of nuisance in some yards, especially where foreign hides are dealt with. The odour emitted is very disagreeable.

4th. More or less of a similar offensive smell commonly issues also from those places where the various scraping processes are carried on.

5th. The running of the old soaks, grainers, and other offensive liquids, into drains. Dr. Davies, medical officer of health for Bristol, showed me an instance where this had been a serious source of nuisance from a kip tannery at Bedminster, the offensive smell coming up the inlets to the drain, the whole length of the street in which the tannery is situated.

6th. The general smell pervading a tannery badly arranged, imperfectly paved and drained and conducted in a slovenly manner, which smell may be carried by the wind to a distance of many yards.

7th. The destruction of the waste tan by burning.

Mode of preventing nuisances.

As to the remedies applicable to these several sources of nuisance:—

1st. It is probable that the free application to the hides, previous to their transference from one place to another, of some efficient antiseptic, such as carbolic-acid solution, would, without injuring the hides, go a long way towards lessening this nuisance. It appears from a letter from the clerk to the St. Olave's, Southwark, Board of Works (contained among the papers above referred to) that such application was effectual in abating the nuisance then complained of.

2nd. I have had several conversations with "kip" tanners upon the subject of the old soaks. I find that the duration of each soaking varies in different yards from 10 days to a month or longer in winter, and that three batches of hides is a common number to soak in succession in the same soak before the water is changed. Nearly all have also expressed to me their opinion, more or less strongly, not that the use of old soaks is indispensable (for then the water would never be changed, but only kept up by additions from time to time), but that they prepare the kips better than new soaks of fresh water do. For some time I thought this was a traditional prejudice, and I am not sure even now that the soaking in old soaks is better because better leather is made with kips so treated than with kips soaked in fresh water. None of the tanners that I spoke to said actually this. But it is allowed that the old soaks soften and prepare the kips more speedily than fresh soaks, and in most yards this is a gain which tanners would be unwilling to dispense with. When I was in Bristol, I visited the "kip" yard of Mr. Cogan, and had some conversation with him about soaks. In this yard old soaks are dispensed with, and, in place of them, the kips are put into a soak through which fresh water is continually running. Mr. Cogan says he made this alteration because he did not wish to continue a nuisance to his neighbours. He tells me from his own experience that the use of old soaks is by no means essential in "kip" tanning, as most tanners imagine. All that can be said in their favour is that they hasten the softening of the hides. He says he gets equally good results from the fresh water which he uses, but that the kips take double the ordinary time to properly soften. Besides which there is less anxiety as to injury of the hides in the soak. It is just one of those questions of trade detail which varied experience alone can solve. The difficulty lies in getting tanners so far to put aside their traditional prejudice, as fairly with open minds to make the necessary experiments. So long as old soaks are in use they should be placed as far as possible from inhabited houses. Or I might make this suggestion, that the soaking should be performed in some country place where nobody can be annoyed, and the soaked kips then be brought in covered carts to the tan yard for "stocking" and the remaining processes.

3rd. The "hauling" is a process constantly going on in a tan yard, and I can suggest no way in which it can be rendered less offensive than it is. The only way of lessening the offence to neighbours that occurs to me, is the removal of the liming pits to a part of the yard where the process may be conducted as far as possible from dwelling-houses.

4th. The same thing may be said of the offence from the various scraping processes. I find on the whole, however, that those establishments are least offensive on this and the last-mentioned ground, in which all these processes are conducted in lofty capacious close buildings ventilated from the roof.

5th. The drain nuisance at Bedminster was abated by disconnecting the tannery from the street sewer and constructing a new drain which carries the offensive liquids into the Avon, about the commencement of the ebb tide.

6th. The general offensive smell proceeding from a tan yard may be greatly mitigated by proper drainage, paving, and general cleanliness, and by the speedy removal of all refuse matter, such as fleshings and refuse lime, from the premises. As regards old tanneries, many of the conditions giving rise to nuisance are the result of long-standing dilapidation, and the limited space within which a growing trade has had to be compressed; a condition of things which forbids much of the orderly arrangement and constructive improvements which are seen in modern tan yards. In such cases as these, entire reconstruction on a larger area has appeared to me to be the only plan of improvement likely to be efficient. Good, firm, even paving on a prepared bottom, well and judiciously sloped to good channels, is essential in all those parts where the scraping processes are performed; and wood, so commonly used in various parts of the surface of old tan yards, should, as far as possible, be avoided. The pits should be well built, and the edges especially constructed of a material that will not readily flake and wear away. And, above all, scrupulous cleanliness should be observed: it is quite practicable in a well paved and well drained tannery. The fleshings and the hair and lime should be swept up and removed at least once a day, and the paved surfaces swept up, no litter being allowed anywhere. Walls fouled with splashings from the beams should from time to time be scraped, and the whole interior of the buildings, where the dirtier parts of the trade are carried on, should be periodically lime-whited. Advantage is also gained by the conducting of the whole process from beginning to end in a close airy building, ventilated from the roof. I may mention as examples of well-conducted tanneries which are free from any intimation of nuisance—Reynold's in Mersey Street, Warrington (market and salted hides), Vicary Bros., in the outskirts of Bedminster (South American hides), and Nickols & Sons, Leeds (kips). In any one of these, the best modes of conducting the trade, so far as the prevention of general nuisance is concerned, may be seen in operation.

7th. The waste tan is a source of some trouble to tanners. They commonly tell me there is no sale for it, and they are compelled to get rid of it by burning; and unless this burning is effected with due precaution the smoke is a nuisance to the neighbours. A similar trouble arises sometimes in white lead works. Some tanners find they can burn it in their boiler fires, mixed with some coal, and to enable them to do this, subject it to strong pressure and convert it into blocks which they dry. Others burn it in an oven or chamber constructed for the purpose, carrying the smoke up a tall chimney shaft.

Preparation of "pickers" hides.

"*Pickers*" are small square blocks constructed of bullock's skin, which are used in the Lancashire looms to receive the blow of the point of the shuttle. They appear to be introduced with the object of preventing the rebound of the shuttle. "Pickers-hides" are buffalo hides specially prepared for the manufacture of these "pickers."

I have visited two such establishments at Broughton, Manchester. The buffalo hides come in dry like kips. They are soaked for three days or a week to soften them, fresh water being used for each lot of hides. They are then limed for about three weeks, unhaired, and if necessary a little fleshed. This is all the preparation which they receive. At one of these establishments I was informed that 200,000 to 300,000 hides are annually prepared.

One of these establishments, if not both of them, is a cause of nuisance to some neighbouring works. I myself recognised the nuisance and the character of the smell as that proceeding from either scutch or some allied material. It was very offensive. I could not visit these works on the day I perceived the offensive smell, but I did so subsequently. My belief then was that the smell had proceeded from the lime pits, some of which were situated close to the boundary wall and leaked into the adjoining premises, partly from the refuse lime and hair scraped off under a shed close to these premises, and partly perhaps from the manipulation of the hides at the lime pits. The remedies for nuisances at such works as these must be the same, so far as they apply, as those applicable to nuisances from tanneries.

At one of these works waste pieces cut off the prepared hides are cut or sliced up into what are called "sizings," after the pieces have been dried by exposure to the air. These sizings go to paper-makers for the preparation of size. At both works the fleshings are dried for use by glue-makers.

The Manufacture of Glue and Size.
Establishments visited.

The Manufacture of Glue and Size.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 17, 1875	Proctor and Bevington.	Bermondsey.	
„ 18 „	Young - -	Do. -	
Jan. 19, 1876	Palmer - -	Lock's Mills, Bristol.	Hair-washing. Wool-washing and drying.
„ 21 „	Turner - -	Bristol.	
Feb. 2 „	Peck - -	Warrington.	
„ „ „	Roberts, Dale, & Co.	Do. -	Manufacture of alkali and oxalic acid.
April 26 „	Hall - -	Nottingham -	Preparation of potted meat.
May 13 „	Freeman Wright -	Needham Market.	
„ 16 „	Vickers and Son -	Manchester -	Bone boiling, soap-making, manure-making, manufacture of sulphuric acid.
June 1 „	Ball and Davis -	Hunslet, Leeds -	Manure making.
„ „ „	Nickols and Son -	Joppa, Leeds -	Fellmongering and leather dressing, tanning, and extraction of fat from scutch.
„ 2 „	Clark and Thackray	Newlay, Leeds -	Leather-dressing, extraction of fat from scutch.
„ „ „	Appleyard -	Leeds.	
Nov. 21 „	Peter Brown -	Old Kent Road -	Extraction of fat from scutch.
„ 24 „	Collins - -	Bermondsey.	
„ „ „	Cripps - -	Do. -	Press fat, extraction of fat from scutch.
Dec. 4 „	Smith & Co. -	Glasgow.	
„ 8 „	Officer - -	Hull - -	Manure making.
„ 20 „	Turney - -	Stourbridge -	Extraction of fat from scutch.
Mar. 28, 1877	Poynter and Son -	Greenock - -	Manufacture of animal charcoal, artificial manure, &c.

The materials used for the preparation of glue and size are various refuse matters, from which gelatin or chondrin can by prolonged boiling be extracted in sufficient quantity to be profitable. The ma-

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On Effluvium-Nuisances, by Dr. Ballard.

terials selected for the boiling vary with the quality of the article it is desired to produce, and the purpose to which that article is destined. The selection of the materials appears to be more important, in the latter point of view, in size making than in glue making. The manufacture of size for some special purposes is often conjoined with other trade processes, so that it will conduce to perspicuity to describe the manufacture of glue and of size separately.

1. *Glue Making.*

1. *Glue making.*

Materials used.

The materials which I have seen in use in glue works for the manufacture of glue are the following:—

a. "Wet" materials: Sheep-pieces or "Spetches" from fellmongers; "fleshings" from leatherdressers and tanners; roundings of hides previously limed; the ears of animals; portions of bones to which tendons are attached; clippings of salted and alumed skins used for covering cricket balls, &c.

b. Dry materials: Damaged pelts (Australian); ox feet salted (Australian and South American); calves' pates (German, &c.); horn "sloughs" (the pith or core of horns); clippings and roundings of parchment; glue pieces from fellmongers, leather dressers, tanners, "pickers" hide works, and trotter boilers; rabbits' pelts and shreds from furriers.

Process.

Prior to making glue of them, all the soft tissues or materials used require to be limed. Such of them as come to glue works from the leather dressers and tanners, and some that come from the trotter boilers, as well as the dry glue pieces and parchment clippings, have been limed already. But such as have not been limed are soaked first in pits containing milk of lime. After the liming, however, the lime has to be got rid of, or "killed." With this object the limed materials are well washed with water. This washing is effected in tanks or vats, or in pits. At some works the washing is effected speedily in large barrels so arranged inside as to throw about the materials by revolution of the barrels. In the case of dry glue pieces, however, it is found sufficient to expose the material to the free action of the carbonic acid of the atmosphere, by exposing it for a prolonged period on racks in erections, covered but open at the sides, provided for the purpose. When thus prepared the materials are ready for boiling. But in some works they are subjected, after being washed, to pressure in a hydraulic press.

The boiling is effected in large open pans or boilers, of which there are usually several together. The pans are each capable of containing several tons of materials. In Young's works at Bermondsey, the charge of each pan is 12 tons of fleshings with one ton of water, the produce of which is said to be about 25 cwt. of glue. A clear space is kept at the bottom of the pan by means of a false bottom of bars. A clear space in the middle is also kept by means of a vertical framework, which can be taken out and replaced at pleasure. The object of this frame and false bottom is partly to give free space for circulation of liquid during boiling, partly to prevent burning, and partly to assist the straining off of the liquid glue. The materials are boiled either by means of a fire beneath the pan or by means of open steam, or by means of both open and close steam. In some works both means (a fire beneath the pan and steam) are provided for the same pan. The pans are usually raised upon a platform approached by a ladder or steps, and are arranged under a roof or shed open at one or on all sides. When horn "sloughs" are used it is customary to build them up around the outside of the central framework, before putting in the other materials. During the boiling, a man is employed in stirring up the contents of the pan from time to time, and in skimming off the fat which rises to the surface.

When the boiling is completed, the fire is raked out, sufficient time is given for settling and partial cooling, and then the liquid glue is drawn out from the space beneath the false bottom along a wooden channel, in which lumps of alum are laid, to wooden troughs ("coolers") on the ground and about a foot wide and deep, in which the liquid is left to solidify into a very firm jelly or size.

During the solidification, froth and some fatty matters rise to the surface, and in some works these are skimmed off; in other works they are left to solidify with the glue, and are dealt with in the next process.

This process consists in cutting the contents of the troughs into slices. The solidified material is taken in blocks from the troughs, and by an arrangement which it is unnecessary to describe are cut upon a bench into slices by women. When there is any scum on the surface of the blocks, it is first cut off and put aside to be returned to the pans.

The slices thus cut off are carried to sheds or erections open on all sides to the air, and are there laid upon nettings to dry spontaneously. When perfectly dry and hard, any mouldiness upon them is scrubbed off with a brush and warm water by women, after which they are laid on a rack to drain and dry, and are finally removed to a chamber heated artificially to between 85° and 120° for a final drying.

The matter left in the pans after boiling is termed "scutch." It is commonly thrown out of the pans in a heap upon the ground, sometimes under the shed where the pans stand, and sometimes in the open air, where it remains until removed to the manure makers. Sometimes it is sent to the manure makers in the condition in which it leaves the pan; at other works it is previously deprived of fat, and at others it is made into manure on the premises without any previous removal of the fat it may contain. The "sloughs," when taken from the pan, are set aside in a separate heap for the use of bone-manure makers.

2. *Size making.*

2. *Size Making.*

Process.

Size of very different qualities is made at glue works. Some destined for rough work is made of similar materials to ordinary glue, while other varieties of a fine quality, destined for the manufacture of gelatin and for use in soups, are made with especial care and precautions, and of very carefully selected pieces, such as "calves' pates." So far as I have been able to gather, it is important that, after liming, the lime should be more completely removed than is necessary for glue making, and for this purpose the pieces are first treated with a weak solution of hydrochloric acid. The boiling is effected in a similar manner to that of glue, except that I have observed that free steam is more frequently used for heating the contents of the pans than in glue making. The liquid size is either run out into little tubs for sale, or into a large vat, out of which it is taken and broken up for packing in tubs. The finest kinds of size for esculent purposes are made into blocks. I have seen steam-jacketed pans used in making the finest kinds of size. Some of the fine kinds of size made at ordinary glue works go to the paper makers.

In some works size is made by first acting upon horn piths with hydrochloric acid and then boiling them with water. I shall defer what I have to say about other modes of manufacturing size until I come to the subject of "bone-boiling."

Nuisances.

Glue works are often a cause of very considerable nuisance to the neighbourhoods in which they are situated. Dr. Davies, the Medical Officer of Health for Bristol, told me that the offensive effluvia from some works I visited near Bedminster created a nuisance at a distance of 400 yards from the works. About five years ago, the proprietor of these works was prosecuted in consequence of a serious pollution of the Malagold stream, which ran through the works, and at that time received all the liquid refuse and sewage from them. There was in the stream a deposit of the depth of three feet, and the stream as it ran through the borough was rendered very offensive. At the time of my visit to Leeds proceedings had also been commenced by the local authority in respect of a serious nuisance from glue works at Hunslet.

Injury to health.

The most obvious kind of injury to health arising out of the effluvium-nuisances proceeding from glue works is that which must be referred to the impression upon the senses made by the offensive effluvia. But on the general principles stated in the early part of this report, the septic atmosphere engendered about ill-managed glue works, and arising out of the decomposition of animal matters in and about the yard, must be held also to be damaging to the health of persons residing in the neighbourhood who may be much exposed to its influence. Probably a high rate of mortality in the population immediately exposed to the effluvia arising from the Hunslet works just mentioned has been in part due to this cause. Dr. Goldie, the Medical Officer of Health for Leeds, in whose district the works are situated, is decidedly of opinion that such is the case. He tells me that during six years ending December 1875, in an estimated population of 1,935 persons, not exceptionally poor or overcrowded, and situated in a comparatively open part of the borough, the mean annual mortality from all causes amounted to 35·66 per 1,000, while that from the five zymotic diseases, smallpox, scarlatina, measles, "fever," and diarrhœa, amounted to 9·12 per 1,000. Taking the whole of the Hunslet ward in which this little colony is situated, the annual death-rate from all causes during the same six years varied from 27·0 to 29·9, the mean being 27·9; and the death-rate from the five zymotic diseases mentioned varied from 4·6 to 6·0, the mean being 5·4. The annual mortality of the whole borough during the same six years varied between 26·4 and 28·5 per 1,000, and that from the five zymotic diseases mentioned varied from 3·6 to 5·9 per 1,000. Dr. Goldie tells me from his knowledge of the district that he is not aware of any conditions of locality or character of population that could possibly account for the great mortality about the glue works, other that the presence of the offensive works themselves.

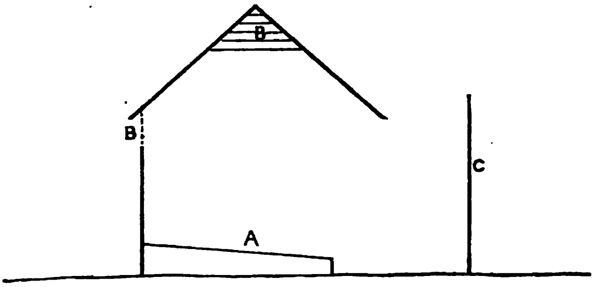
Sources of effluvium nuisance.

The sources of nuisance from glue works may be any of the following:—

1st. The deposit, accumulation, or too long detention of moist "fleshings," or other decomposable material in the yard. At the Hunslet yard above mentioned I found a large heap of several tons of fleshings which had become absolutely putrid, and were only fit for manure making. The proprietor told me in extenuation, that he had unfortunately overbought himself; such an occurrence may be sometimes unavoidable, especially in small works where pans are not kept in reserve for dealing with such emergencies as irregularities in the delivery of materials, &c.; but the fact of this having led to nuisance disposes at once of an argument sometimes used by manufacturers of various kinds, that it is against their interest to incur waste.

2nd. The effluvia of the steam issuing from the boiling pans.—Where the best selected materials are in use this is tolerable, unless when the limewhited inside. The following is a rough plan of a proper scutch shed:—

Fig. 8.



A. Raised platform. B. Louvres. C. Screen.

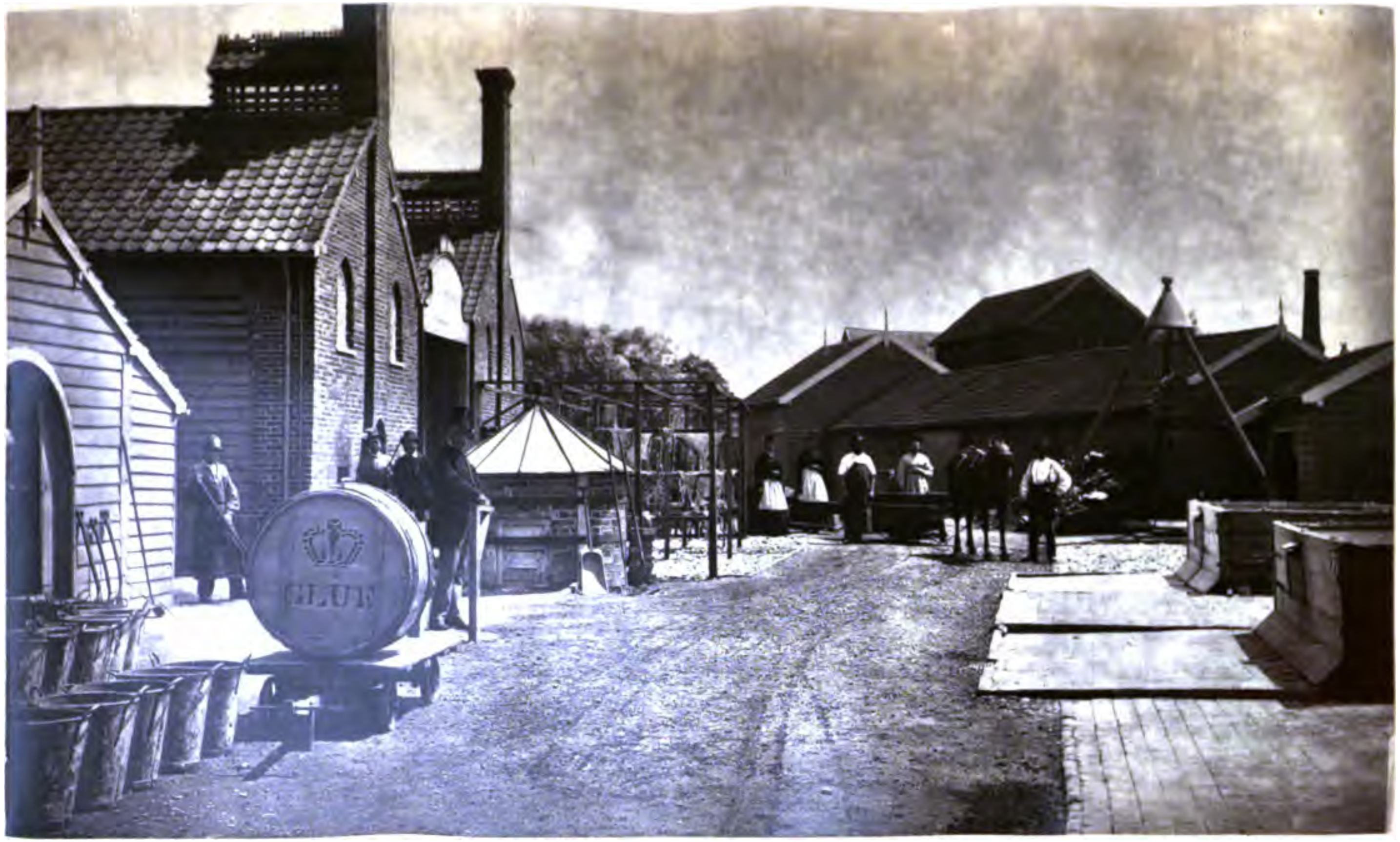
At Nickols, Joppa, Leeds, and at Clark and Thackray's, Newlay, Leeds, the "scutch" is dealt with, immediately on its removal from the pans, for the extraction of the fat it contains, and the conversion of the "scutch" into a cake which is almost devoid of odour. And I should think that while preventing annoyance to neighbours, the proprietors find the process profitable. On its removal from the pans the "scutch" is thrown into a tank of water, and some sulphuric acid being added, free steam is thrown in. The fat which rises is taken off, and the residue is put into coarse bags and subjected to pressure in a well-closed hydraulic press, into which more steam is thrown. The liquid matters pressed out run into a tank, where more fat rises and is collected. The cake is stored on the premises without giving offence until it is convenient to have it removed. But in some other works I have visited where the same process is used, I have seen the cake laid in a heap and exposed to the weather in the open yard ferment and become offensive. Such dry cake should be stored under cover. Messrs. Turney, of Stourbridge, have an arrangement of a different character for separating fat from scutch before its removal from the premises. It will be described when the subject of scutch manure making comes under consideration.

4th. The general untidiness and superficial filthiness of glue yards is only another instance of slovenliness showing the conservative power which attaches to ancient tradition. It need not be so, and in the interest of the manufacturer would be better not so. All parts of the premises should be firmly and evenly paved with appropriate materials, and duly sloped to good channelling, and well drained throughout. No litter of any kind is necessary, or should be permitted. The surface should be kept constantly swept up, and washed down with water from time to time. Every scrap of gelatinous glue should be gathered into proper receptacles for return to the pans. Leakages from channels and troughs should be immediately made good. The interior and edges of the pans, and everything about them, should be kept clean and free from deposits, and tidiness of working be maintained, as it readily may be, by due regulations for the establishment.

The remedies for nuisances arising out of the manufacture of scutch manure, will be treated of under the heading of artificial manure making.

Description of two establishments

I cannot conclude this part of my Report more usefully than by giving the description I find upon my notes of two glue-making works; the one about the worst conducted that I have visited, and the other beyond all comparison the best conducted.



BOILING-HOUSES—TANKS AND "FLATS."
TRANSFERENCE OF "COOLERS" OF GLUE TO THE DRYING DEPARTMENT

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

1. Works at Hunslet.

1. Works at Hunslet, Leeds.—The area of the entire premises is about 2 acres. The total annual production of glue is stated to be about 150 tons, and 50 hands on an average are employed. The surface on which the works are erected slopes back from the road. It is only partially paved, and in the parts which are paved the paving is most defective and very irregular, so that pools of offensive liquids are to be seen in various parts of the surface of the yard. Heaps of fleshings, "scutch," &c. are deposited in all parts of the open yard, and in one place was a large heap of putrid fleshings, only fit for manure. The boiling pans are steam heated, but are very filthy, with "scutch" lying about them, in the shed and outside the shed, and dried upon the edges of the pans. At the rear of the works, where the cooling troughs are, the ground is saturated with spilt glue and filth, and there are large heaps of refuse accumulated, part of which was being manufactured by hand labour into a kind of manure.

2. Freeman Wright's works.

2. *Freeman Wright's* works, Needham Market, Suffolk. — These works are in two parts, situated on either side of a lane and railway. On the one side all the wet parts of the process are conducted, and on the other side all the dry parts. About 50 tons of glue are produced annually, and 25 hands on an average are employed. The materials used are the usual "spetches," "fleshings," small dry clippings of skins and hides, rabbits' pelts and shreds, and trotters. The moist limed materials not immediately required for use are put into tanks containing a weak solution of lime, and each tank is, as well as the washing tanks, ticketed with the dates of reception of the material, the dates when it ought to be removed, and other particulars of its contents. There are (in consequence of the lowness of the ground) but few pits here, and the washing and clarification of the "pieces" (equally with the preservation of them), performed in other works in pits, are performed in raised tanks instead. Mr. Wright finds this arrangement convenient and conducive to cleanliness. The pans are clean, and heated by open fires. "Scutch" is not allowed to accumulate. It is chiefly at once put into bags or into casks, which are immediately covered down and then sent away by rail. At the time of my visit there were only one or two casks on the premises in consequence of a delay in their return, and the "scutch" in small quantity was lying tidily in two small heaps upon a platform beneath a shed in the yard. It was not offensive. When Mr. Wright is from circumstances compelled to retain it for a time, he covers it with a carbolic powder. What struck me most forcibly at these works were the perfect cleanliness, tidiness, and order which prevailed in all parts, even in those parts where the wet parts of the process were being conducted. There was no dirt or litter of any kind about the works ; all was well swept up. The surface was everywhere well paved with the best bricks made in the county (Woolpit bricks), which are hard and do not readily flake. The pavement is laid upon a bottom of chalk, and is properly sloped, channelled, and drained. On the side where the glue is dried, and the further final processes conducted, equal cleanliness and tidiness prevailed. In the drying sheds even, all dirt had been removed from the stairs and platform, and the sorting rooms and warehouses were swept clean. In short, there was as much difference between these works and the ordinary run of glue works, as there is between the stables and stable-yard of a nobleman's mansion and a London cab yard and stables. And all this was not the result of a special preparation for my visit, for I only arrived in Ipswich on one evening, and visited these works early the next morning. Besides, Mr. Elliston, the Medical Officer of Health for the district, told me that whenever he has visited them he has always found them in a similar condition. Mr. Wright has kindly permitted photographs of his

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works to be taken for the purposes of this Report; and I append them with the object of showing in how tidy and cleanly a manner it is possible to conduct processes which are too commonly performed in an uncleanly and slovenly manner. They show correctly the condition of the premises at the time of my visit.

The Manufacture of Prussiate of Potash.

Establishments visited.

The Manufacture of Prussiate of Potash.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
June 1, 1876 -	— Foster - -	Leeds - -	Removing grease from currier's scraps.
" " " -	Samuel Foster -	Do.	
" 14 " -	McKenny -	Clayton, Manchester.	
" " " -	Sir E. Buckley -	Do. do.	

Process.

Prussiate of potash is made by heating together crude carbonate of potash, and various kinds of refuse animal matters, such as "flocks" (the waste or refuse woollen dust from wool mills), clippings of leather, horn, hoof, &c. The process, where I have seen it, is conducted in a closed building with louvre openings in or along the roof. Iron pots about 2 to 3 feet wide and deep are used, and are arranged in a bank and heated by fires underneath them. There are always more pots than are in use at any one time, since they wear out after a few weeks' use, the material of the pot furnishing the iron necessary for the formation of the salt. Each pot is furnished with a flat iron cover, capable of partial removal for introduction of material, and also with a stirrer inside, the vertical shaft of which passes through the cover, and which is set in motion by a mechanical arrangement passing along horizontally above the whole series of pots. The potash being put in, the animal material is added in shovelfulls from time to time, the removeable portion of the cover being raised for the purpose; the heating operation is continued for three or four hours, and then the contents of the pot are taken out and thrown into a tank of cold water, which dissolves out the prussiate. A carbonaceous matter remains after solution, and is usually sent away to sewage or manure works to be used as a deodoriser. The further processes are wet processes, and consist only in recrystallization of the salt upon strings suspended in the crystallizing tank.

Effluvium nuisance.

During the heating process flame and offensive smoke issue from the gaps about the covers of the pots, and directly from the pots themselves when from time to time it becomes necessary to raise the cover to put in fresh material. This smoke fills the house, and, issuing from it, is often a source of nuisance to neighbours. I am not, however, aware of any other injury to health that it occasions beyond such as may arise from the impression made upon the senses. I am informed, however, that such works as these have created nuisance perceptible at a distance of 100 yards from the works.

Mode of preventing nuisances.

The best mode of preventing nuisance which I have seen in operation was at Buckley's works, at Edge Lane, Clayton, near Manchester. The arrangements here, which have been most effectual in obviating a nuisance previously much complained of, were devised by Professor Roscoe, of Owens College, Manchester. They are represented in Plate 5 From the back part of the lid of each pot a pipe passes first upwards

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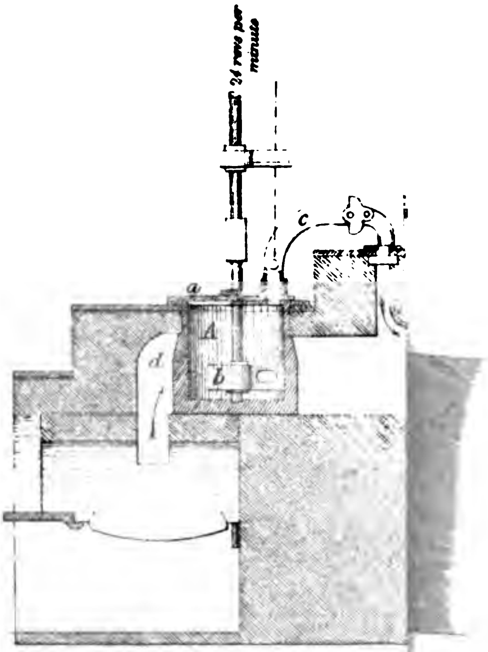
ASTOR, LENOX AND
TILDEN FOUNDATIONS.

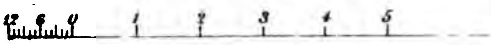
PLAN SHEWING ARRANGEMENT OF THE POTS, STIANCHESTER



Cross Section.

A Iron pot
B Fire place
a Cover of pot
b Stirrer
c Hinged pipe conveying vapours to the flue
d Flue surrounding the pot & leading to the chimney shaft.

Scale



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then horizontally, and lastly, vertically downwards to the back part of the flue which surrounds and heats the pot. The pipe is hinged at the junction of the short horizontal and the descending part, to allow of the lid with the part of the pipe connected with it being raised. The result is that the smoke and fumes instead of escaping into the building are drawn down to the flue where they meet the flame of the fire and are consumed, the products of the combustion being carried off by a tall chimney shaft. The building, in which 21 pots are arranged along one side, is very capacious, being about 50 yards long by 11 yards wide and 11 yards high. It is lighted all along the top of the roof by skylights, below which are louvres. It is also ventilated by openings in the side and end walls. Eight pots were working when I made my visit, and there was no offensive smoke or odour perceptible either in the works or outside them.

THE BOILING OF FLESH, TRIPE, TROTTERS, OX FEET, &c., AND THE PREPARATION OF "NEAT'S FOOT OIL," AND THE TRADE (SOMETIMES ASSOCIATED) OF PREPARING GLUE PIECES.

The Boiling of Flesh, Tripe, &c. and Preparation of Glue Pieces.
Establishments visited.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Harrison - -	Belle Isle - -	Knackery.
„ 19 „	Briar -	South Bermondsey	Preparation of glue pieces, manure-making.
Dec. 11 „	Shaw - -	St. George's, Southwark.	Knackery.
Jan. 19, 1876	Neat & Co. -	Bristol.	
„ 21 „	Kent - -	Do. - -	Do.
April 26 „	Hall - -	Nottingham -	Size making, bone boiling.
May 17 „	Eardley - -	Manchester.	
„ „ „	Lane -	Do.	
June 1 „	Watson & Co. -	Leeds - -	Fat melting, soap-making, &c.
„ „ „	Hargreaves -	Do. - -	Fat-melting, bone boiling.
„ „ „	Harland - -	Do.	
„ 15 „	Saycell - -	Salford.	
Oct. 26 „	Cattle Market -	Deptford -	Slaughtering, &c.
Nov. 24 „	Cordrey - -	Bermondsey.	
Dec. 2 „	Abattoir - -	Moore Street, Glasgow.	Do.
„ 4 „	Hodgkinson -	Glasgow - -	Knackery.
„ „ „	Glen Park, Knackery	Do. - -	Do.
„ 8 „	Nicholson -	Little Driffield -	Leather-dressing, manure making, &c.
„ „ „	Barron - -	Sculcoats, Hull -	Bone boiling, fat melting, manure making.
Jan. 10, 1877	?	Near Portsmouth -	Knackery.
„ 19 „	Stronach - -	Belle Isle -	Do.
Feb. 13 „	Adams - -	Birmingham -	Do.
Mar. 15 „	Walton - -	Near Cambridge -	Knackery, piggery, manufacture of artificial manure.
„ 27 „	Arthur - -	Greenock.	
Various times	Various piggeries.	—	

off, the bones are removed and set aside for the manure maker, and the liquor, which is highly gelatinous, is said to be run off into the drains. Some, spilt about on the ground, had there gelatinised at the time of my visit. Some, it was said, is mixed with other waste materials on the premises for the manufacture of a manure. *c.* The shanks or long bones of the foot are similarly boiled in open pans, and are then thrown into cold water, sorted when dry, and sold for making knife handles. If *intended for food* the ox feet are not split, but are boiled in separate boilers for the preparation of "cow-heels;" otherwise the process is similar to that above described.

Mode of dealing with sheep's trotters.

2. Sheep's trotters.—*If not intended for food*, which is when they have undergone such an amount of decomposition as would unfit them for such use, they undergo three limings; the first liming is little else than soaking in water, in which they decompose somewhat. A most offensive putrid smell arose when the contents of this tank were disturbed and when the trotters were taken out. The skin is then removed, freed from wool, and dried for "glue pieces." They are then thrown as they are into boiling pans where the fat is boiled out; and the residue, bone, skin, and hair, is turned out in a heap upon the ground. The mass is then sorted, the longer bones are put in one place for purchase by manufacturers of bone articles, the smaller bones are set aside for the purposes of the manure manufacturer, and the remaining soft matters are thrown upon the heap of lime refuse, &c. outside the works. The fat skimmed off is often very offensive; it is put into casks and sold, it is said, to soap boilers. *If intended for food* the trotters are first scalded in a boiler, and, when they are taken out, boys are set to get the hoofs off. They are then taken into an open unpaved shed furnished all round with bins, at which women sit, who with a knife cut off the loose skin and scrape the hair from the edible portion. They are then ready for boiling.

Manure making.

At these works manure is also made from a mixture of lime-grounds, wool, hair, and cotton waste, to which the gelatinous liquor from the pans is added, and all is turned over from time to time with a fork. The mixture heats and emits an offensive ammoniacal odour. Sometimes sulphuric acid is added.

Effluvium nuisances.

The businesses which I have been describing are often a source of nuisance from the offensive effluvia proceeding from them. But they are not all alike in this respect, since they vary with the character of the matter boiled and the pains taken to avoid producing nuisance. When the matters dealt with are putrid or semi-putrid, the nuisance is necessarily very much greater than when fresh substances are boiled for human food. But even in the latter case tripe and trotter boiling houses are apt to be a source of nuisance to close neighbours; and in many places that I have visited health officers have been requested to advise as to the mode of obviating the nuisance they have occasioned. The offensive odour from the more offensive establishments has produced in some persons the ordinary disturbances of health ordinarily produced by offensive effluvia which make a strong impression on the senses; but I have had no satisfactory evidence given me of injury to health of a deeper kind. Still, on general principles, such businesses as that last described, in the conducting of which putrid emanations are largely given off, cannot fail to injure health, if they are established in close populous neighbourhoods.

Sources of nuisance.

The sources of nuisance from this class of establishments are:—

1st. The vapours issuing from the boiling pans. They are always more or less disagreeable, and especially so if they enter the doors and windows of neighbouring houses; but more particularly are they

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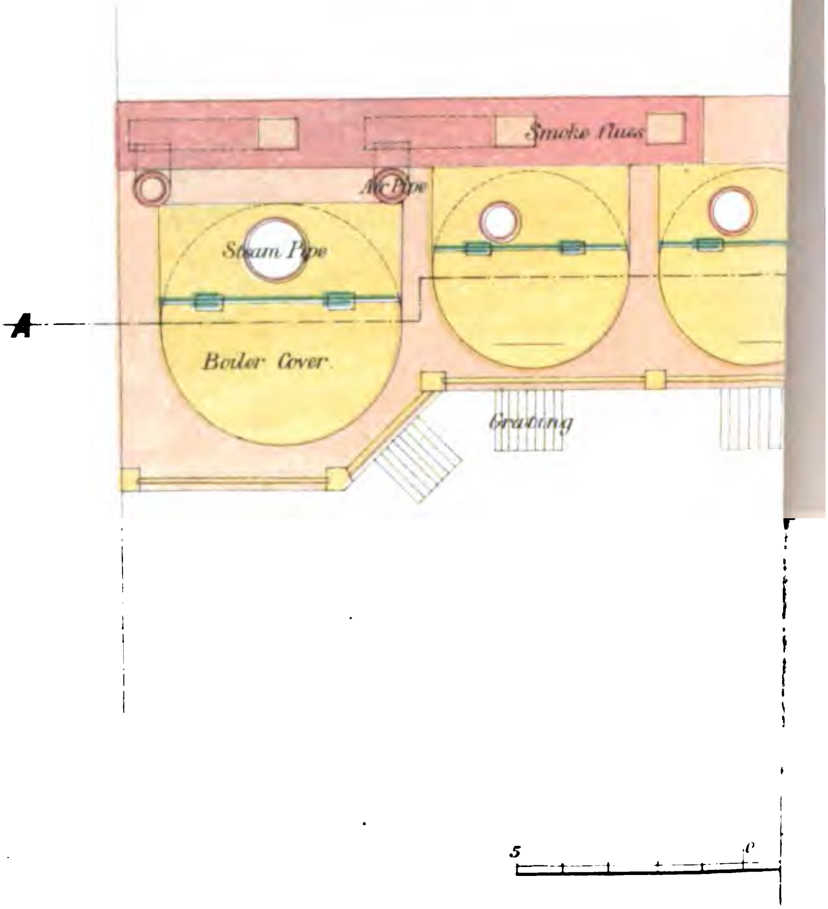
PLAN OF ARRANGEMENT IN
AND CARRYIN



ıd even disgusting when semi-putrid matters are boiled, pen at a knackery, which, especially in the summer time or uggy weather, receives dead horses from a distance, or has means of disposing of an unusual number of carcases brought remises at one time, or as invariably happens daily in such nts as that last described.

vapours issuing from the boiled materials laid aside to cool.

vapours issuing from the liquor from the pans when it is nd allowed to run along open channels to a drain gully.

general offensive odour proceeding from an untidy, filthy, kept establishment where animal matters are dropped and the floor, and defile the premises generally with the odour decomposition, or where accumulations of decomposing refuse kept upon the premises.

offensive odour proceeding from the lime pits, especially rbed, and when their contents are taken out.

exposure of wet glue pieces to dry in the open air or under ed.

e effluvia proceeding from associated trades such as the manu- manure from the refuse of the works.

rds the remedies applicable to these several sources of :—

Modes of preventing nuisances.

small tripe and trotter boiling establishments it may suffice to the boiling operations beneath a hopper brought down tly low and closed in at the sides of the boiler, and to conduct n, issuing at times when the boiler is open for the removal of ts contents, into a chimney with a good draught and discharging an elevation above the level of adjoining houses. But the boiler ould be provided with a lid, and there should be a pipe to convey am from the space immediately under the lid into the ashpit of the ich ashpit should be provided with a well-fitting door. The arrange- is one which I shall have to mention again in connexion with some trades, as bone boiling and fat melting. (See Fig. 4, p. 203.) At on & Co.'s in Leeds, the vapours from the covered boiling pans are n off by a fan (as they are also from other boiling and fat melting on the premises) and driven through a furnace fire: this is very ctual. At Stronach's knackery at Belle Isle the vapours from the ler (closed and heated by free steam) are conducted into the fire of boiler which furnishes the steam. This also is effectual in obviating isance.

But one of the best arrangements for large establishments that I have seen is in use at Adams' knackery in Lord Street, Birmingham. It is an arrangement for catching and condensing the vapours, and was put up under the direction of Dr. Alfred Hill, the Medical Officer of Health for the borough: it has proved most efficient. Plate 6 is the plan of the arrangement. At this establishment there is along all one side of the slaughter-house a row of six boiling pans set in the usual way, and each heated by a fire beneath. They are enclosed above in a sort of closet, formed by a wooden partition reaching to the roof of the building above, and below extending down to the front part of the top of the boilers. Opposite each boiling pan there is in the partition a shutter which slides upwards, and which can be raised whenever it is requisite to obtain access to the boiling pan. Each pan is, moreover, closely covered down with a wooden cover, and from the upper and back part of each pan, beneath the cover, a pipe leads to a 10-inch main pipe which runs the whole length above the pans and within the hopper, and receives contributions of vapour from each pan. This pipe finally makes an exit at the exterior of the building, and here communicates with an oblong condenser made of sheet iron and filled with coke. The condenser, which measures about 14 feet long, 3 feet from above downwards, and about 14 in. from side to side, is inclined a little in its long diameter; at the lower end it receives the pipe from the boilers, and from its lower border another small pipe conveys away the water produced by the condensation of the vapour; the cooling agent is the outside atmosphere to which the condenser is exposed on all sides. The upper end of the condenser communicates by two air pipes with the flues from the fire places. When the boiler lids are raised, the vapour that issues rises towards the roof, and is conveyed from the interior of the closet into the chimney shaft by escape steam pipes provided for the purpose.

2nd. At knackeries the second source of nuisance may be obviated by throwing the boiled meat directly from the boilers into a tank of cold water, or (better still) through which cold water is constantly flowing. After a few minutes the surface is sufficiently cooled to give off no more vapour. At one time this arrangement was adopted at one of the knackeries at Belle Isle, but its use has been abandoned. It would scarcely be requisite to adopt any similar plan of procedure at a tripe and trotter establishment, since the matters boiled are less apt to be offensive, are small in bulk, and cool much more speedily than lumps of horseflesh; beside which I do not know how far it would affect the appearance of the cooked food.

3rd. The obvious remedy for the third source of nuisance is to permit the liquor to cool in the pans before discharging it, and to discharge it into the drain through a covered channel of some kind.

4th. The remedy for the fourth source of nuisance is to be found in due structural arrangements, scrupulous cleanliness, and the daily proper removal of refuse matters from the premises. The buildings in which all the dirty parts of the business are conducted should be airy and well-lighted. The floor should be evenly paved, preferably with cement or some other jointless paving, and duly sloped to properly constructed gullies leading to well-laid pipe drains. The walls should be covered with a smooth layer of cement or other material capable of being washed, to such a height from the floor as shall include all parts likely to be defiled by splashings, &c., and the remainder should be limewhited periodically. No litter should be allowed, but proper impervious vessels should be provided to contain any materials which may be undergoing any process of manipulation, and the benches and tables should be even, and capable thus of effectual cleansing. And after the close of each day's operations, the floor, lower parts of the walls, and all utensils that have been in use, should be thoroughly washed and cleansed. All refuse should be at once placed in impervious moveable receptacles fitted with covers, and should be daily removed from the premises in these receptacles to some place where they cannot be a nuisance.

5th. It is difficult to say what should be done to avoid nuisance from the lime pits in which bits of putrid skin and trotters are put to soak. The offence from these is much greater than from the lime pits in fellmongers' yards, since in this latter case the matters soaked in them are not absolutely putrid. It appears to me, however, that this soaking operation and all the manipulations connected with it ought to be performed in a closed building ventilated at the roof, and not in the open air or in open sheds. Should this not be sufficient to protect neighbours from the offensive smell, the air might be drawn out of the building by some mechanical means, and conducted through a fire or a sufficiently capacious cylinder or chamber filled with good dry wood char-

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coal, before being permitted to escape externally. It is also worthy of consideration whether some antiseptic solution such as a solution of carbolic acid might not be used with the lime in the pits, without injuring the value of the skin soaked there to the glue maker. Certainly some effectual deodorant should be added to the waste lime and liquors before they are discharged from the pits and during removal from them. When deposited upon the premises the waste lime should, at least, be at once covered with some inches of fresh earth, and the removal off the premises should be effected in well-covered carts; or it might, when taken from the pits, be at once put into the covered carts in which it has to be removed.

6th. The drying of glue pieces in the open air or under open sheds may be unobjectionable enough in certain localities, and is highly objectionable in the close vicinity of inhabited houses. But it is an old-established practice, and I have seen no other followed anywhere. Nevertheless, it has appeared to me that the drying might be more expeditiously and equally well effected by some more civilised procedure. The use of heat for the purpose would probably be objectionable, but I imagine there could be no valid objection to drying the pieces in a moderately warm chamber, through which air may be mechanically drawn or driven and then caused to pass through a screen or cylinder of fresh wood charcoal before it is allowed to issue externally, so as to deprive it of offensive odour. Such an apparatus would be especially applicable for use in the winter months and in damp weather when glue pieces dry but slowly under the ordinary conditions.

7th. The remedies for nuisances from associated trades will be considered under the head of each particular manure-making trade.

THE MANUFACTURE OF FISH-LIVER OIL.

ESTABLISHMENTS VISITED.

The Manufacture of Fish Liver Oil.

Establishments visited

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 22, 1875	Head - -	Stonehouse, Plymouth.	Fellmongering, leather dressing.
„ 8, 1876	Deheer - -	Hull.	
„ „ „	Sisson - -	Sculcoats.	
„ „ „	Musk -	Do. - -	Manufacture of artificial manure.

Process.

Oil is obtained from fish livers, *e.g.*, the livers of the cod or hake, by heating in an iron pan or boiler with a fire beneath. This is the mode in which I have seen it obtained in Hull and Plymouth. When the oil has sufficiently exuded, it is dipped off by hand and put into appropriate vessels. Sometimes the residue is transferred to a second pan to undergo a second process of heating, by which more oil (of inferior quality) is obtained. The final residue is then in some places placed in cloths and subjected to pressure in a screw or hydraulic press, in order to get out the last portions of oil. The mass (or the residue if not pressed) is set aside for conversion into manure either on the premises or elsewhere. The operation is carried on mostly in closed buildings, and the pans are usually covered and the covers luted down. The vapours which pass off through cracks in the luting, or when the covers are taken off and the oil or refuse removed, is inexpressibly offensive. The odour adheres to the person and clothing for a long time after

Offensiveness.

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a very few minutes visit to one of these houses. I think the offensiveness is greater even than that of the process of gut scraping, which is one of the most offensive processes that I am acquainted with. Under bad arrangements the offensive smell extends for some distance round the works, and is very nauseating. I myself on one occasion of a visit to such an establishment had the greatest difficulty to restrain vomiting, and the memory of the smell almost makes me feel sick as I recall it.

Sources of nuisance.

The sources of nuisance may be: 1st. The vapours proceeding from the boiling pans when open for dipping, &c., and during the process of dipping and removal of refuse, or escaping from the pans through cracks in the luting. 2nd. A general offensive odour proceeding from filthy and uncleansed premises. 3rd. Accumulations of refuse matter. And 4th. The manufacture of fish manure from the refuse upon the premises.

Modes of preventing nuisances.

The remedies applicable to the nuisances from this offensive business are as follows:—

1st. The process should always be conducted in a closed building, and never in the open air or under an open shed. At Deheer's manufactory in Hull I found the vapours from each covered boiling pan conducted by a pipe passing through the wall of the building to an ordinary worm condenser outside. Such vapours as were not thus condensed were carried into a fire. The watery matters condensed were collected in a barrel and from time to time run off into a drain. The principle of this arrangement, viz., condensation of so much of the vapours as might be condensible and burning of such vapours as remained uncondensed, is good, but in practice has not been very satisfactory at these works in consequence of imperfections in details. Offensive vapours still passed out through cracks in the luting of the pan covers, showing that there was no traction influence exerted by the fire upon the vapours within the boiling pan. It would have been better to have arranged that the vapours should actually have been drawn off from the boilers through the condenser to the fire. The Medical Officer of Health also informed me that nuisances arose sometimes in adjoining dwellings from the condensed liquors discharged into the drains, and the escape of offensive odours from imperfectly trapped inlets in and about the dwellings. At Musk's establishment in Sculcoats a different method of avoiding nuisance is in use. The building in which the boiling is carried on is carefully closed up, the only supply of air being from a lantern louvre in the roof and a pipe passing through the roof to the height of about 40 feet. The openings of the fireplaces are all within this building, and all air which the fires require must be drawn from the interior of the building through the ash pit. This, so far as I can see, has been effectual. There was less offensive smell too within the building itself than in other similar works I have visited, due, I believe, to the stricter observance of cleanliness. I am disposed to think also that the process would be less offensive than it is, if the boiling were carried on in steam jacketed pans, since there would be less risk of burning the contents of the pan than where an open fire is used. It would be well also to cover the boiling pans with a large hopper, so as to catch and convey away to a sufficiently tall chimney such vapours as arise in the process of dipping, and to dip the oil from the boilers into a funnel placed beneath the hopper, from which funnel a pipe should convey the oil to a covered tank. The offensiveness arising from the removal of the residue might be in a measure avoided by allowing the residue to cool before removal: and the pressing of the residue might be effected in a close chamber communicating by a pipe with a fire or tall chimney, as recommended for greaves pressing (p. 207).

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2nd. A remedy for much of the nuisance arising from the second class of sources would be found in a proper construction of the building and in the observance of scrupulous cleanliness. The floor should be laid with cement or some other even, jointless material, and after each day's work should, as well as the tops and sides of the boilers, be cleansed thoroughly with hot water and soda, so as to remove all grease; and the inner walls and ceilings should be frequently and periodically limewhited. The yard and outside premises generally should also be kept clean and free from litter of refuse, &c.

3rd. The refuse from the pans should be conveyed, if necessary, from one part of the premises to another in impervious vessels closely covered down and, daily cleansed; and, so long as it is retained upon the premises, should be retained in such vessels and removed from the premises in them.

4th. The remedies applicable to the manufacture of manure will be mentioned when the subject of manure-making comes under consideration.

Fat Melting, &c.

Establishments visited.

FAT-MELTING. DIP-CANDLE MAKING.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 3, 1875	Brown	Whitechapel.	
„ „ „	Symes	Belle Isle.	
„ „	Featherstone	Do.	Butterine-making.
Dec. 11 „	Abel	St. George's Southwark.	Bone boiling.
„ „ „	Hoare	Do.	Do.
„ „ „	Anderson and Cattley.	Do.	Soap making.
„ 18 „	Tucker	Plymouth	Distillation of palm oil, composite candle making.
Jan. 10, 1876	Potts	Southampton.	
„ 18 „	Furlong	Bristol	Bone boiling, manure making.
„ „ „	Thomas & Co.	Do.	Soap-making, alkali making. Distillation of palm oil, &c., composite candle making.
„ „ „	Lyddon	Do.	
„ 19 „	Roger Moore	Do.	Soap-making.
„ „ „	J. B. Moore	Do.	
„ 20 „	Matthews & Co.	Do.	Manufacture of railway grease, black varnish, and soft soap; oil-boiling.
„ 21 „	Lawson and Phillips.	Do.	Soap-making, alkali making.
„ „ „	Skull	Do.	(Rendering lard.) Bacon curing.
„ „ „	Dole	Do.	(Do.) do.
Feb. 12 „	Burgess	Warrington.	
„ 23 „	Harris	Stratford	Bone boiling.
„ „ „	Seaborne	Do.	Do.
April 1 „	Fitch	Melton Mowbray	Fellmongering, splitting pelts.
„ 1 „	?	Melton Mowbray.	
„ 6 „	Stevens	Loughborough.	
„ „ „	Ball	Do.	

either a screw or hydraulic press; the remaining fat is thus pressed out, and the solid matter is converted into a dry cake known as "greaves." The residue from steam melting with sulphuric acid is so broken down that it is useless for greaves making. Sometimes it is pressed, however, but the product is only fit for manure-making; but usually it is sent away as it is, or is converted with gypsum or other materials into a kind of manure upon the premises of the fat-melter.

5. When the tallow thus made is going to be used for soap-making nothing further is done with it, but when for candle making it may be subjected to other processess. It is, for instance, sometimes washed by heating it with some water either by an open fire or by free steam. The object is to wash out the acid: any impurities which may be present settle with the water when the tallow cools.

6. When tallow for candles is to be bleached, the operation is usually performed by melting by means of free steam in a lead-lined tank with peroxide of manganese and sulphuric acid, and by subsequent washing as above.

Special modes of rendering.

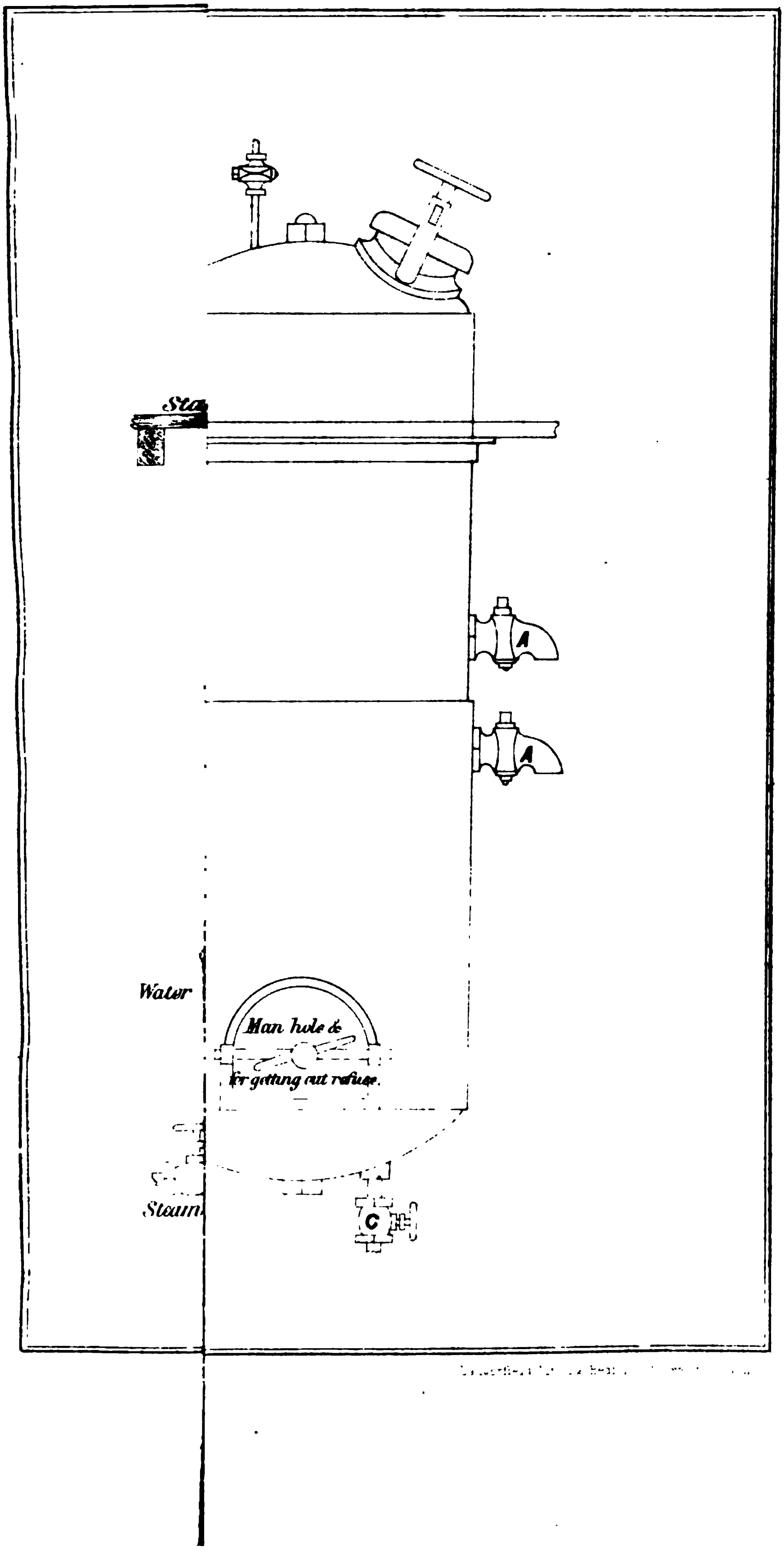
There are, however, other methods of rendering, for special purposes, in use by certain manufacturers, and two of these are worthy of particular mention.

At Dole's, Bristol.

One of these is by the use of a digester or strong iron cylinder. Such a digester is used by Mr. James Dole, of West Street, Bristol, for reducing and extracting the fat from various refuse morsels of fat, bone, or skin which accumulate in the course of his business as a pork butcher. The apparatus was constructed for him by Mr. Miles, engineer, of Bristol, who has been good enough to furnish me with a drawing and description of it. (Plate 7.) The apparatus consists of a strong iron cylinder provided above with a charging hole closed by a sliding cover, a man-hole towards the lower part for the discharge of solid refuse, and various taps at different levels for drawing off fat, &c. A pipe brings in steam at a pressure of 60 to 80 lbs. on the inch, below a false bottom, and another pipe at the side supplies water when requisite. A vent cock above serves to regulate the pressure and permit of the off of blowing steam. The apparatus being charged, steam is thrown in for about six or eight hours. If a heavy charge has been introduced the fat can be drawn off by one of the uppermost draw-off cocks. It can, if requisite, be floated to position for drawing off by turning in water through the water-feed valve. Where only a light charge is used, it is considered better to draw off into a tub all the liquid matters, which consist of water and fat together, by the lowermost tap, and to skim off the fat when it is cold. This apparatus extracts gelatine as well as fat, and any bones introduced with the charge are rendered perfectly friable. The steam discharged from the vent pipe can be conveyed away, if it be necessary for the avoidance of nuisance, in the event of matters used in the digester being productive of offensive vapour.

At Cook and Hall's, Bow-bridge.

The other arrangement is one patented (April 1875, No. 1,501) by Messrs. W. Cook and S. Hall, of the East London Soap-works, Bow, for the production, from the freshest beef suet, of a fat which is used for the manufacture of butterine. The fat is first thoroughly disintegrated and reduced almost to a pulp in a mill of peculiar construction, and is then dealt with as follows. There is a wooden chamber or closet provided, high enough for a man to enter and work in, with a passage up the centre. At the two sides are racks inclined a little from above downwards, and on to these racks are slid in from the outside, after the manner of drawers, shallow iron trays, which, when slid in, slope downwards towards the central passage of the chamber. Below the free lower edge of each row of trays there is an


Sta
A
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Water
Man hole &c
for getting out refuse.
Steam
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TILDEN FOUNDATIONS.

open iron gutter or channel which, with other similar channels, communicates finally with a pipe leading to a receiver outside. The comminuted fat is laid in thin layers upon these trays, and the temperature of the chamber is by means of steam pipes raised to about 120° Fahr., or to such a heat as shall be just sufficient and no more to liquefy the fat, which then runs off into the gutter and is conveyed away to the receiver outside, leaving behind only such shreds and small portions of tissue as are not liquifiable by heat. The product is remarkably fine and fit for food. The residual matters still contain from 6 to 7 per cent. of tallow; they are mixed with kitchen stuff and rendered by the steam and acid process.

Process of dip-candle making.

In making dip candles, a small oblong dipping vessel is used to contain the tallow, which, as it is required, is ladled out of a pan in which it is remelted usually by a fire beneath. The temperature of the tallow is at first only just high enough to impart fluidity, but the last dippings are made in tallow thoroughly melted and quite fluid. In the winter it is sometimes necessary to prevent the too rapid cooling of the tallow by putting a small pan of charcoal or a lamp or gas jet beneath the dipping vessel.

Nuisance from fat-melting.

Fat-melting for the manufacture of dip-candles is a process which appears to be carried on in most towns, and is often a source of more or less serious nuisance. Fat-melting houses are commonly situated in the oldest and dirtiest parts of towns. The reason appears to be that, in former years, when there was less intercommunication between towns than there is now, and when tallow candles were in more common use, their manufacture in towns was almost as much a necessity as town slaughtering. Very many of the melting-houses I have visited had, I found, been established in the same premises for half a century or a century, and I found too that often no alteration had, during that long period, been made in the character of the process or of the plant. Towards the close of last year I was instructed to advise the Town Council of Southampton, who had asked for assistance of this kind, as to the best mode of dealing with a fat-melting nuisance in the very centre of the town. The Town Council had received a memorial from householders in the High Street, urging them to procure them relief from the disagreeable and sickening smell of the establishment referred to. The smell extended (as I have known to happen in many other instances) for 100 yards at least beyond the premises. Now this was an old-established melting-house, the nuisances from which had been borne with for a great many years, but were at last felt to be tolerable no longer. And this, from what I can learn, is the sort of history attached to most melting-houses that sanitary authorities have had to deal with. The nuisance is borne with until some habitual neglect of ordinary precautions on the part of the fat-melter leads to a cry for its summary and complete suppression.

Injury to health.

I have not been able to discover that any other injury to health has been attributable to the fat-melting nuisance than that dependent upon its disagreeable impression on the senses. In hot weather, especially, the smell of melting fat is, from its associations, unpleasant and even nauseating to some delicate persons, who at that season are unpleasantly impressed even by the smell proceeding from their own kitchens. In the Southampton case above referred to, one person stated that his workwomen had to give up their work in the summer time, in consequence of their health being injured by the closeness of the room arising out of the necessity of keeping the windows shut to exclude the intolerable smell. Others complained of being made sick, and one lady, not generally a delicate person, of frequently suffering from diarrhœa after about half an hour's exposure to the smell.

Sources of effluvium nuisances.

The following are the sources from which nuisance from a melting-house may arise :—

1. An offensive smell may proceed from the store-room into which fat is received. When it contains any considerable quantity of stale and semi-putrid fat, it may under some circumstances be a nuisance to near neighbours. This, however, is a minor nuisance.

2. The vapours from the melting-pan itself may be the source of nuisance. This is especially the case when the rendering is effected by a fire under the pan, for then any neglect of stirring may result in some over-heating of the pan and partial charring of some of its contents. Sometimes, when the pan is nearly empty, actual ignition has taken place: this is not only dangerous but occasions an exceedingly foul odour from the burning material. The vapours from the pan are most disagreeable when the fat is stale or semi-putrid, and when stale kitchen stuff or stale ship's fat are rendered.

3. A further source of nuisance may arise from the ladling out of the boiling fat or tallow into the strainer or vat into which it is removed from the melting-pan. Even when means have been adopted for preventing nuisance during the actual process of rendering, this may still require attention. At such times, if there be a lid to the pan, the lid is raised and vapours escape freely, as they also do from the strainer and vat. The vapour is most offensive when the last portions are being removed, since these are then apt to become over-heated or partially charred.

4. Greaves pressing is also almost invariably a source of more or less nuisance, since it has to be performed while the tallow is liquid and hot enough still to give out offensive vapours.

5. Finally, many melting-houses are so filthy and the floors so encrusted with dirt and stale rancid grease as to give issue to a most disagreeable smell perceptible to passers-by : like that of stale fat on the premises, it is calculated to give offence under some circumstances to immediate neighbours.

Modes of preventing nuisances.

All these sources of nuisance are quite capable of prevention.

1. Offensive kinds of fat that can be covered up, such as kitchen-stuff, should be so covered, or stored in a chamber or closet communicating with the external air only through the medium of a screen containing wood charcoal. But it is a practice with fat-melters to spread out stale butchers' fat on the floor or on hooks in the store-room to sweeten by exposure to the air before putting it into the melting-pan. Where such fat is received and is so treated, provision should be made for its exposure in some part of the premises where it cannot be a nuisance to immediate neighbours. Fresh fat that is not about to be rendered immediately should be hung upon hooks in the store-room, and the cleaner and sweeter this room is, the more likely is the fat to remain sweet. In fact the method of preventing nuisance commences properly at the slaughter-house. As soon as it is removed from the animal it should be laid on racks where it may be freely exposed to the air, and it should not be packed until it is quite cold and hard. This is the practice pursued at Messrs. Cook's receiving house at the Deptford abattoir.

2. I am disposed to believe that the principal source of nuisance in rendering is occasioned by the offensive and semi-putrid condition of the material rendered. Whatever the method of rendering adopted, those establishments are least complained of which are the most particular in melting nothing but very fresh butchers' fat. Still the method of rendering has a great deal to do with the amount of nuisance. Of the methods of rendering in common use, that by the use of steam, either

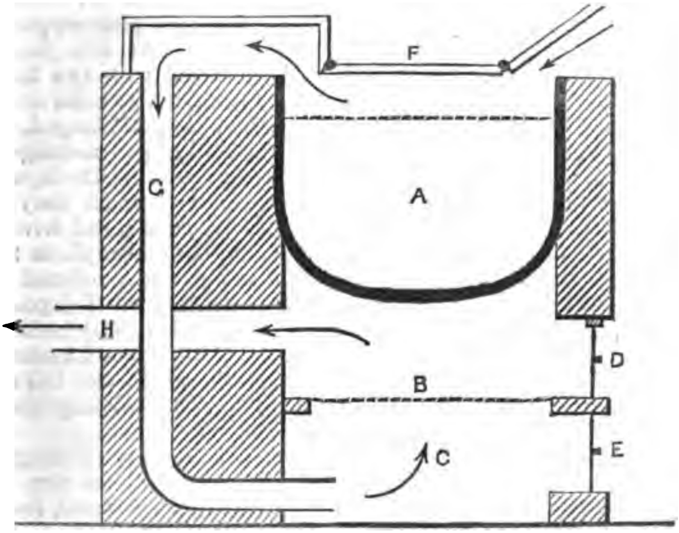
Steam rendering preferable to fire rendering.

free or applied by means of a jacketed pan, is on the whole by far the least offensive, and in towns is the only method which, as a rule, should in my opinion be permitted. But by steam melting, when sulphuric acid is used, the profit from the "greaves" (which is used as food for dogs and is worth about 16*l.* per ton) is lost. Rendering by a fire beneath the pan cannot, as I am given to understand by some melters, be avoided when one object is the saving of the greaves. This, however, is a mistake, since edible greaves may be made and are made at some establishments already mentioned, where steam rendering without the use of acid or by means of a jacketed pan is in use. The method of rendering by fire heat should be adopted only in localities where it can be no nuisance to neighbours, and should be confined to the rendering of nothing but the freshest butchers' fat. It is now a common practice to cover the melting-pans with an iron cover capable of being raised, provided with a hinged portion in front, which hinged portion can be raised for the purpose of inspecting the operation and stirring the contents of the pan, and by carrying a flue or channel from the space between the cover and the pan into the ash-pit of the fire. The ash-pit door being closed, the fire draws all the air it requires from the space above the pan, and is supposed to consume all combustible vapours.

Mode of consuming vapours from fire rendering.

The following diagram shows the arrangement referred to; the arrows indicate the course of the air-current for the supply of the fire:—

Fig. 4.



A. Pan containing fat. B. Fireplace. C. Ash-pit. D. Door of fireplace. E. Ash-pit door. F. Double hinged cover or lid. G. Pipe from beneath lid to ash-pit. H. Fire-flue.

To a certain extent this is effectual, but the workmen have too much control over the arrangements to allow of it being in all cases fully effectual in preventing nuisance. (*See also* "Bone-boiling," p. 228.) Besides, it does not act at all in this sense when the entire lid is raised for ladling out the tallow. Neither is it constantly the case that the fatty vapours are so thoroughly consumed by the fire as to render them inoffensive. Hence, where this method is adopted, the flue from the fire should be conducted to a chimney of good height. This is done at Chancellor and Anderson's Candle Factory in Reading, where the method of melting by an open fire is carried out without any nuisance, as the Medical Officer of Health informs me. The chimney shaft with which the flues from the fires at this establishment communicate is about 100 feet high. The necessity for raising the lid to stir the contents of the pan may in large works be avoided (and the rendering expedited also), as at Cook's Soap Works in Bow, and at J. Knight and Son's works in Old Gravel Lane, by the use of mechanical means, the shaft of a stirrer within the pan passing through the pan cover.

Mode of preventing nuisance in steam rendering.

Where none but fresh butchers' fat is used, rendering by free steam and a little sulphuric acid may be executed, even in open tanks unprovided with any special means of disposing of the vapours, with a very minimum of nuisance, or without the production of any nuisance at all. At Alderman Burgess' melting-house in Warrington, for example, which I visited on a day when the process was actively going on, I could perceive no offensive smell anywhere in the neighbourhood, and scarcely any smell, and certainly no disagreeable smell, from the tanks, even in the melting-house itself. And this melting-house is situated in a closely built part of the town. The same process in use at Higgins' establishment in Manchester is similarly conducted without nuisance, as I am informed by the Inspector of Nuisances of the district in which the works are situated. But still it is not practicable for a fat-melter always thus to obtain his fat quite fresh. Stale fat and kitchen-stuff, &c. must be melted by some one, and then the vapours even from the steaming process are necessarily offensive. The nuisances may in some such cases be obviated by covering the rendering tanks and conducting the vapours into a high chimney shaft. This is the plan adopted successfully at Sudlow's establishment at Salford. At this place the chimney shaft is 100 feet high, and being connected with two furnaces has a strong draught. Or the vapours may be driven by a fan or drawn by the chimney draught through a fire before being discharged. This method may be seen in use at Harris's bone-boiling and melting-house at Stratford, and at Watson & Co.'s large soap works in Leeds, at both which establishments (the former a comparatively small one) a fan is in use to draw off the vapours from the covered tanks, and drive them through the boiler fires. The health officers of both these places tell me that no nuisance from the rendering arises at the works referred to. I have especially mentioned Watson's, because this method of disposing of the vapours from all parts of his large premises (where soap boiling and tripe boiling are carried on as well as fat melting), was, I understand, voluntarily adopted in consequence of complaints of nuisance 150 to 200 yards off, which have not since recurred. The chimney shaft at Watson & Co.'s is 150 feet high.

Condensing arrangements.

At Lyddon's in Bristol I found an arrangement for effecting some condensation of the vapour before passing it through the fire. This manufacturer (a candle-maker) steams his fat in a close vessel, from the upper part of which a 12-inch stoneware pipe conducts the vapours into a large underground tank or cistern of water (but not into the water itself), from which an iron pipe conducts them into the boiler fire and from thence to a chimney about 50 feet high. A nuisance, however, which has been a good deal complained of, arises in this case when the water of the tank is (about once in six weeks) run off into the drains. At such times an offensive smell issues from untrapped or imperfectly trapped drains in the vicinity. Brice & Co., in Glasgow, effect condensation also, but in a different manner. There is a long iron pipe freely exposed to the air and leading to the fire; steam condenses in this and flows down to the lowest part of the pipe near the fire, where a short descending portion of pipe, narrowed at the lower open end, permits of the discharge of the condensed water. The principle being maintained, such a pipe might if requisite be connected with a worm condenser, or carried to any distance round the outside of the building (as is done in some sulphate of ammonia works) before reaching the fire. The collection of condensed water in this way would permit of any requisite use of deodorants before throwing it into the drain. In Mr. Cook's evidence, given before the Select Committee of the House of Commons on Noxious Businesses in 1873, he stated that at his Hoxton works he, at that time, successfully dealt with the offensive vapours from his stuff-melting pans by a process of condensation. He passed them through a flue filled with coke, upon which water constantly dripped from a pipe pierced with small holes; from this flue the vapours were driven by a fan into the ash-pits of the steam boilers and through the fire.

Applicability of steam rendering to soap works.

I must here add a few words upon the applicability of steam rendering to the use of the soap boiler and candle maker respectively. It is now by no means an uncommon practice with soap boilers to render the fat they receive for soap making by the free steam process. I need merely instance Anderson and Cattley in Southwark, Thom & Co. at Pendleton, and Watson & Co. at Leeds, as large firms who follow this practice. And all large soap makers melt out the tallow which they purchase in casks by means of free steam. But the following portion of the evidence given by a soap boiler (Mr. E. Knight), before the Select Committee of the House of Commons on Noxious Trades in 1873, appears to indicate that all soap boilers are not agreed upon its applicability :—

Mr. Knight's opinion.

" (2967.) How is this melting conducted in your instance, by open fire or by steam ?—By fire; the butchers' fat by fire, and the kitchen-stuff also by fire.

" (2968.) You dissolve by steam the major part of the fat, which you receive in tubs, do you not ?—No, the major part we do by fire, not by steam.

" (2969.) Do you use steam for that purpose at all ?—No, not for our butchers' fat.

" (2970.) Could you use steam for the whole process ?—No, we could not."

Mr. Knight, from his extensive experience, is so important an authority that I thought it right to visit his works in Old Gravel Lane, and to learn more fully his views upon this subject. He makes at these works both yellow and mottled soap, and for the yellow soap the only tallow used is that which he makes from butchers' fat, except when he has not sufficient of such tallow on the works, and then tallow made from kitchen-stuff is used in addition. As a rule the latter kind of tallow is only used for the manufacture of mottled soap. Both kinds of material are (for soap-making purposes) rendered in the same way, namely, by fire heat; the pans are closely covered and the contents stirred by machinery during the rendering. The only difference is that the vapours from the rendering of butchers' fat are conveyed at once into a chimney shaft about 54 feet high, while those from the kitchen-stuff are first conducted into the ashpit of the fire and through the fire on their passage to the chimney. The explanation given me by Mr. Knight as to his statement of the inapplicability of steam rendering to his processes was, that at his works a superior kind of yellow soap of superior hardness is made, and that he has besides the advantage of the profit arising out of the manufacture of greaves. He tells me that, at the time he gave the evidence in question, he was under the belief (a belief which he held in common with other old soap-boilers) that the superior hardness of his soap was in some way really dependent, in part at least, upon the use of fire-made tallow, but that he is now quite satisfied that this is not the case, and that equally good and hard soap may be manufactured from tallow made by the steam process.

Applicability of steam rendering to candle making.

When first I commenced this inquiry, I had had no experience in steam rendering for the preparation of tallow for candle-makers. All the fat-melting I had seen in candle-houses, up to that time, had been effected by a fire under the pan, and the manufacturers told me that steam melting would not answer their purpose, since the tallow produced was not sufficiently "strong." I hesitate to say that this opinion is altogether the result of prejudice, since one manufacturer told me that, while he made tallow for ordinary dip candles by the steam process, miners insisted upon having candles made with fire-made tallow for use in the mines. But they also insisted upon having them coloured green. I have repeatedly questioned candle makers who use steam-made tallow upon the subject, and they assure me that candles made from such tallow are quite as good as those made from fire-made tallow. The first conversation I had upon this matter was with Mr. Phillips, of the firm of Lawson and Phillips, Bristol. Mr. Phillips, although now a soap-boiler, was formerly a candle-maker. He assured me that the only ground on which steam-made tallow could be regarded as less "strong" than fire-made tallow was, that it might (as in the winter) have some watery matter entangled in it, and in that case all that is necessary is to remelt the tallow at about 212°, and to keep it thus liquid for a short time. But even this appears to be not always necessary, since I have frequently seen candles, which burned well without "spitting," made of steam-made tallow which had undergone no such previous preparation. Mr. Knight of Old Gravel Lane, who makes dip candles as well as soap, renders fat for this purpose (candle-making) by the steam and acid process, and bleaches with bichromate of potash. But he agrees with many candle-makers in saying that the tallow so made is "less strong," and the candles made from it are more apt to gutter than candles made from fire-melted tallow. Nevertheless they fetch he says the best price.

Mr. Duncan Knight agrees with Mr. Phillips in the opinion that the "strength" of the tallow may be fully restored, however, by driving off the water it contains, when thus made, by heating to 212°. It has been suggested to me, from another source, that possibly the alleged less strength of steam-made tallow may be dependent upon the solution of gelatinous or other animal matters out of the non-fusible elements of the fat. It is probable, however, that the subsequent heating would, by driving off the water they are associated with, render even these matters innocuous or no more injurious to the tallow than the non-fusible animal matters contained always in fire-made tallow.

Rendering by free steam without acid or by close steam, as in a jacketed pan, is, equally with steam and acid rendering, preferable to rendering by fire, so far as the production of nuisance is concerned; but the vapours will be offensive even with the adoption of these processes, if the fat be stale and tainted. Hence similar precautions against creating nuisance ought to be taken. But, if there be anything in the opinion before referred to as to the "less strength" of steam-made tallow, the objection would not, I imagine, apply to tallow melted by close steam.

Cook's process instructive.

Rendering by Cook's patent process is a proceeding wholly devoid of nuisance, and it appears to me that (setting the details of the process aside) the principles on which it is founded have an important application to the rendering of fat for other purposes than butterine making. These principles are the fine comminution of the fat prior to rendering, and the effecting of the rendering at a low temperature—a temperature insufficient to cause offensive effluvia by the action of the heat upon the fat and non-fusible tissues. The success which has attended Mr. Cook's process leads me to suggest that, by taking the trouble to thoroughly comminute the fat used, ordinary fat melting might probably be effected readily and speedily by close steam at a comparatively low temperature by those who from prejudice (or even on substantial grounds, if there be any such) object to use the free steam process. Mr. Duncan Knight tells me that at Old Gravel Lane they once attempted to comminute fat for making a superior material for exportation to Paris, by means of toothed rollers working into each other in pairs; but that the process was slow and laborious, and that the teeth of the rollers were apt to be broken by portions of bone or other harder matters occurring in the fat: but this is a difficulty which a little modification of the machinery might overcome.

3. The only mode that I know of by which the nuisance arising during the removal of the tallow from the melting-pan, when fire heat is employed, can be lessened, consists in raking out the fire or reducing it to a minimum during the process, and by the erection of a large hood over the pan and receiving vat which shall conduct the vapours given off into a tall chimney. Great care is necessary, more indeed than workmen can for the most part be trusted to give, so as to avoid nuisance even thus. But from what I heard at Nottingham from the Inspector of Nuisances there, the provision of such a hood at some works I visited, and which had previously been complained of, has proved effectual. But for the reason above assigned it is not to be recommended. The difficulty of carrying out this part of the process without nuisance is an additional reason why steam rendering should be the only method adopted in towns and populous places. Where steam is used, the rendering tank being sufficiently elevated, the tallow may be run out by a pipe and tap from a part of the covered tank sufficiently distant from the bottom to avoid the dregs and water, which deposit after the steam has been shut off long enough for the tallow to clear itself of them. This plan may be seen in operation at Lyddon's in Bristol (comparatively small works), and at Watson & Co.'s, Leeds (one of the finest and largest works of the kind in the country). I once heard a theoretical objection raised to this, viz., that the pipe would become choked with consolidated tallow; but in practice I have not seen this accident happen, nor has it ever been mentioned to me by fat-melters who run off their tallow thus. Should it occur, the pipe might readily be cleared with a cane, or the accident be prevented altogether by a steam jacket to the pipe. But, under ordinary circumstances, where fresh fat only is used and sufficient steaming given to it, the tallow may be ladled out in the ordinary way without nuisance. Steam melting also appears, so far as my observation has gone, to save the necessity of straining the tallow. Most of the dregs settle in the receiving tank, and what little may remain are removeable by subsequent settling or by washing and subsidence.

4. The nuisance arising from "greaves"-pressing also disappears with the adoption of the steam and acid process. In cases, however, where greaves must be pressed, the nuisance may be abated by closely boxing up the press and the receiving vessel, and by conducting the vapours by a pipe into a fire or tall chimney shaft.

5. Cleanliness is the remedy for the fifth source of nuisance which has been referred to. Most of the melting-houses I have visited, especially the smaller, I found to be indescribably filthy, and the floor and steps dangerous from the slipperiness arising out of years upon years of in-trodden grease and dirt. Some were very old and dilapidated premises, which appear as if they had never been cleaned or whitewashed from the time of their establishment as melting-houses. In such places the scraping and cleansing of the floors, &c., would be, I should think,

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On Effluvium-Nuisances, by Dr. Ballard.

a source of actual profit, since the grease is easily recoverable, or might command a ready sale for recovery. A melting-house is not by any means necessarily a dirty place, nor need the process be carried on in a dirty style. To such as may desire to be convinced of this, I recommend a visit to Chancellor and Anderson's, at Reading, where the melting-house and candle-house are as clean and tidy as the well-conducted kitchen of a gentleman's house.

The Manufacture of Soap. Establishments visited.

THE MANUFACTURE OF SOAP.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 11, 1875	Anderson and Cattley.	St. George's Southwark.	Stuff-melting.
„ 21 „	Victoria Works	Plymouth.	
„ „ „	Millbay Works	Do.	
Jan. 18, 1876	Thomas & Co.	Bristol	Fat-melting, alkali making, distillation of palm oil, &c.
„ 19 „	Roger Moore	Do.	Fat-melting.
„ 20 „	Matthews & Co.	Do.	(Soft soap), fat-melting.
„ 21 „	Lawson and Phillips.	Do.	Fat-melting, alkali making.
Feb. 21 „	Crossfield	Warrington	Alkali making.
May 16 „	Vickers and Son	Manchester	Bone-boiling, size making, manufacture of artificial manure and sulphuric acid, &c.
„ 30 „	Maguire	Salford	Tar distilling, manufacture of cart grease and sulphate of ammonia.
„ „ „	Thom & Co.	Pendleton	Fat-melting.
June 1 „	Watson & Co.	Leeds	Fat-melting, tripe boiling, &c.
„ 15 „	Duckworth	Salford.	
Nov. 16 „	Cook	Bow Bridge	Fat-melting.
„ 21 „	J. Knight and Sons	St. George's-in-the-East.	Fat-melting, and candle making.
Jan. 10, 1877	Doudney & Co.	Portsmouth	Fat-melting.
Mar. 6 „	Price & Co.	Battersea	Fat-melting, purification of paraffin, distillation of palm oil.

Materials used

The materials now used generally in soap-making are a caustic lye of soda or potash, and various animal or vegetable fats or oils. The soda lye is made from soda ash, (a crude calcined carbonate of soda, manufactured at the alkali works chiefly in the North of England and in Scotland,) by means of quicklime. Potash lye is similarly made by the action of lime upon dissolved crude carbonate of potash. The animal fats employed are chiefly tallow, either imported from abroad, *e.g.*, from Russia, Norway, Canada, Australia, South America, &c., or manufactured at home by rendering butchers' fat or kitchen stuff. Fat produced by the boiling of bones and from the skimming of glue pans and other kinds of refuse fat from different trade processes are also used. What is known as ship's fat, also used by some soap-boilers, is fat which has been rendered by ships' cooks, during voyages, from the refuse fat of the food consumed on board. Fish oils are used for the manufacture of some kinds of soft soap. The vegetable fats or oils used are principally palm oil, cocoa-nut oil (both solid substances), and cotton seed oil. Rosin or colophony, which is not properly a fat, but is capable of combining with alkalies, is also used. So also are some other materials, such as silicate of soda, which need not be specially enumerated.

Process.

The fats and oils used in soap-making are, chemically, compounds of a fatty acid, stearic, margaric, oleic, palmitic, cocinic, &c., as the case may be, with glycerine as a base; and saponification chemically consists in causing the combination of these acids with soda or potash, the glycerine being eliminated. When these fatty acids are combined with soda they form a "hard" soap, and when with potash a "soft" soap.

The process of rendering the alkali caustic by the use of lime is one which can by no possibility create nuisance, so that I need not describe it. But some soap-makers manufacture their own soda ash from salt cake which they purchase or bring from other works, even when they do not manufacture the salt cake on the premises. Crossfields of Warrington, Thomas & Co. of Bristol, and Lawson and Phillips of Bristol, do this.

Hard soap.

The hard soaps made in this country are prepared from the various solid fats mentioned, and are of different kinds according to the use to which they are to be applied. The two most ordinary varieties are known as "yellow" and "mottled" soap. The use of rosin previously powdered is confined to the manufacture of yellow soap.

Some soap boilers themselves render the butchers' fat or kitchen stuff, the tallow from which they are about to use at their works; and some being bone-boilers also, manufacture the bone fat that they require. Others neither render fat nor boil bones, but use only such materials as arrive at their works in casks. The coarser kinds of fat, such as that made from kitchen stuff, ship's fat, &c., are used only, or almost only, for the manufacture of the more impure (mottled) kind of soap. Legitimate mottling of soap results from the irregular diffusion through the mass of more or less oxide or sulphide of iron and of some little of the impurities of the fat. There is, however, another kind of mottling (very readily distinguishable) due to an artificial colouring material introduced into the soap.

At some works the tallow, palm oil, or cocoa-nut oil used are dug with a spade out of the casks and thrown at once into the boiling pans; and at all works this is the mode in which ship's fat and rendered kitchen stuff is extracted from the casks. But in many large works it is now the practice to extract tallow and other solid fats from the casks by a process of steaming. The cask is laid upon its side and supported in this position, with the bung-hole downwards, over a tank, and a jet of steam is thrown in at the bung-hole. The fat as it melts runs out into the tank, from which it is pumped up into the boiling pans.

Palm oil is usually bleached before being used for soap-making. The methods of doing this which I have seen in use are: 1. The warming of the oil with bichromate of potash and sulphuric acid. 2. The raising of the oil in a strong iron cylinder heated by a fire beneath to a temperature of about 480° Fahr.; and 3. The heating of the oil in an open tank to about 200° Fahr. by means of close steam, and then blowing cold air through it by means of a fan or blower.

The boiling pans are large iron pans set in brickwork and capable of making at one time many tons of soap. The following description of the process of soap boiling given by Professor Church* is so concise that

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* British Manufacturing Industries. London: Stanford, 1876.

I do not hesitate to quote it here:—“Some of the oil or fat, or mixture
“ of such matters, is first put into the pan, then some weak caustic lye
“ (sp. gr. 1·05 to 1·08) is added, the mixture being agitated and gently
“ warmed at first, further quantities of lye, of increasing strength,
“ being added from time to time, and the heating continued until a
“ kind of emulsion is formed, then fat (and rosin in making yellow
“ soap), and then more lye is added from time to time, while the boiling
“ is continued until the proper quantities and proportions of each have
“ been introduced, and the saponification, or action of the alkali upon
“ the fat, is complete. Precautions against excessive frothing and
“ boiling over have to be taken, while the completion of the change
“ must be ascertained by the occasional withdrawal and examination of
“ small samples from the pan. The next step of the process is the
“ separation of the soap from the mass of the liquor, a separation or
“ parting which is commonly made by the addition of about 10 lbs. of
“ common salt to every 100 lbs. of fatty matter employed. Soap being
“ insoluble in strong saline solutions separates in a nearly dry and pure
“ condition, floating to the top of the liquor. The layer of soap may
“ be drawn off, still melted or fused, at this stage of the operation, and
“ separates further into a clear portion and a mottled portion; or the
“ more usual plan may be adopted, of running off the spent watery
“ and saline liquor below, leaving the soap in the pan to be afterwards
“ treated in the following way. To the soap is added more lye, and the
“ whole is once more heated, then the mixture is allowed to settle for
“ some hours. Next the liquor is run off to be used in the next charge,
“ while the soap, which now contains more water than before and a
“ slight excess of alkali, is cast in iron frames and moulds, and when
“ cold cut into blocks or bars by means of wires.” Soap boiling is now usually effected by means of steam, either “free,” *i.e.*, thrown directly into the pan, or “close,” *i.e.*, led through a coil of pipe within the pan. At some works I have visited the first part of the boiling is effected by free steam, and the latter part by means of a fire beneath the pan.

Soft soap.

“Soft soap” is made by boiling with potash lye various kinds of fish oil, seal or whale oil, rape, linseed, or cotton seed oil, a little tallow being sometimes added to produce a speckled appearance in the finished product. Two or more of these several oils are sometimes used together, the price governing very much the kind of oil used at any particular time. The process is up to a certain point not dissimilar to that for hard soap. A lye of only moderate concentration is used first, and a sort of emulsion is formed which gradually loses its opacity and becomes more viscous. Excess of foaming is prevented by beating down the foam as it rises. More and stronger lye is then added until the soap remains transparent and viscous when cold. The whole is then boiled to expel excess of water, the material being constantly stirred. The soap, not being, like hard soap separated by means of salt, contains when finished all the materials used in making it, in one form or another, except so much of the water as has been boiled off.

Effluvium nuisance.

Prior to the time (about forty years ago) when British alkali came to supersede commonly the use of kelp or barilla (prepared by the lixiviation of the products of combustion of certain kinds of sea wrack) the manufacture of hard soap was a very offensive process and used to give rise to much external nuisance. The waste liquors were especially disagreeable, and it was customary to boil them down again for the recovery of the salts they contained and the production of “soapers' salts,” and subsequently for making “black ash” by heating with lime and sawdust. This process was very offensive, it is said, from the evolution of sulphuretted hydrogen. But, since the use of British alkali, all this offensiveness has been got rid of, and soap-making is now carried on in many places without creating nuisance at all, or with the production of very much less offensive effluvia than was formerly the case. Under existing circumstances the waste liquors are inoffensive, and can safely be run off into town drains. Nevertheless, it still sometimes happens that offensive effluvia from soap works are complained of by persons residing in their immediate vicinity.

Sources of nuisance.

The sources of offensive effluvia may be one or more of the following:—

1. The rendering of butchers' fat or kitchen stuff on the premises.

2. The melting of strong-smelling fats or tallows out of the casks by steam. Foreign tallows vary much in their odour, partly on account of their source, and partly, perhaps, on account of differences in the mode of their production. Some have a very disagreeable odour, and the vapours proceeding from their melting out are also very offensive. To some persons the smell proceeding from the melting out of palm oil or cocoanut oil is more or less disagreeable.

3. The bleaching of palm oil gives rise to the evolution of the irritating offensive vapours of acrolein, which where only small quantities of oil are dealt with may produce little or no annoyance, but which when large bulks of oil are dealt with may give rise to decided nuisance.

4. When fats which have an offensive odour, such as fish oil, are used, the vapours from the boiling pans may be very offensive and give occasion for complaints from persons residing near the works, who may be annoyed by the entrance of the offensive effluvia into their houses. One fat of this character is what is known as "ship's fat." When obtained from vessels which make only short voyages this fat is received at the works in a fresher and much less offensive condition than when it is obtained from vessels which make long voyages. In the latter case the fat has more or less of a bilge-water odour, smelling in fact more or less strongly of sulphuretted hydrogen, especially the fat in the lower parts of the casks; and when such fat is thrown into the pans and melted in the process of conversion into soap, the vapours are distinctly offensive. When sweet fats are used the vapours from the boiling processes are not offensive (some people call them aromatic and refreshing); but however this may be, it is not agreeable to be constantly exposed to them.

The soap being made, the after processes are inoffensive.

The only other probable source of nuisance at soap works is the dealing with the tank-waste when soda ash is manufactured on the premises. The character of this nuisance will vary with the mode of dealing with this substance. (*See* "Alkali Making.")

I am not aware of any instance in which the effluvium nuisances from the actual process of soap making have been accused of producing injury to health.

Modes of preventing nuisances.

The remedies for the effluvium nuisances arising from soap works are as follows:—

1. The remedies against the nuisances proceeding from the rendering processes have been considered in the section on fat-melting.

2. The nuisance arising from the melting out of offensive tallow, &c. by steam, may be prevented by covering the whole space occupied by the receiving tanks, and the casks supported over them, with an iron cover capable of being raised or let fall by means of pulleys above, or by performing the operation within a close chamber. A pipe may be carried from the cover or chamber to the ashpit of a fire, or a fan may be used to draw off the vapours, when they may be dealt with either by a process of condensation or by passing them through a fire. For the purpose of condensation any one of the arrangements described in the

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On Effluvium-Nuisances, by Dr. Ballard.

section on fat-melting may be adopted. The sort of boxing up above mentioned may be seen in operation at the soap works of Anderson and Cattley in Southwark, and Thomas & Co. in Bristol. The former have a communication between the exterior of the cover or closet (wooden) and the chimney shaft. At the latter works there is no such communication, but, the cover being of iron, the action of the cold air upon the outside probably causes the condensation of some of the vapours within. The iron cover at these works, resembling a large dish cover, dips at its lower edge all round in a shallow channel containing water, which thus forms a water lute. There would be no difficulty with such an arrangement as this (were it requisite) in facilitating the condensation by causing a spray of cold water to fall upon the outside of the cover.

3. The remedies applicable to the offensive vapour proceeding from the bleaching of palm oil will be described when the subject of refining and bleaching oils, and the manufacture of palmitic acid, comes under consideration. It may suffice to say here that the principles of tho remedies lie in drawing off the vapours, and either passing them through a fire or condensing them by the agency of water.

4. Offensive vapours from the actual process of soap boiling are best dealt with on the plan adopted by Watson & Co. of Leeds. At these works all the boiling pans are covered over more than half their extent by wooden covers, from the back part of which a pipe conveys the vapour to a main pipe or channel leading to one of the boiler fires, where they are discharged into the mouth of the ashpit by means of an adaptation provided for the purpose. A fan, interposed in the course of the main channel, serves to draw off the vapours in such a way that none of them escape into the works.

The remedies for the nuisances arising from the dealing with the tank waste of alkali making will be treated of, when the subject of alkali making comes under consideration.

THE MANUFACTURE OF ARTICLES FROM BLOOD.
Establishments visited.

THE MANUFACTURE OF ARTICLES OF COMMERCE FROM BLOOD.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Smith - -	Islington.	
" " "	Hyland - -	Do.	
Jan. 5 1876	Hales - -	South Bermondsey.	
Feb. 23 "	Hempleman -	Stratford.	
April 26 "	King - -	Sneaton, Nottingham.	
May 17 "	Walshe - -	Manchester Corporation abattoir.	Manure making.
" " "	Howarth - -	Manchester.	
" " "	Smith and Forrest	Do. - -	Distillation of tar and resin.
" " "	Laing & Co. -	Do. - -	Manufacture of British gum and starch.
" 22 "	? - - -	Boy and Barrel Yard, Leeds.	Slaughtering.
Oct. 4 "	Lewis & Co., or Gall.	Glasgow.	
Nov. 15 "	Voultier - -	Croydon abattoir.	
" 24 "	Do. - -	Bermondsey.	
Jan. 31, 1877	Coles - -	Near Calne -	Manure making.
Feb. 2 "	Riley - -	Plymouth.	
" 5 "	King - -	Bristol.	
Mar. 28 "	W. & C. Forrest -	Brediland, Paisley	Gut scraping.

Blood collected in slaughter-houses is dealt with differently in different parts of the country, in preparation for different technical uses. It will be convenient, although not, perhaps, strictly orderly, to treat of all the processes to which it is subjected in the same section.

Preparation of Blood for use by Turkey-red Dyers.

Preparation of Blood for Turkey-red Dyers.

At some places in the north and north-west of the country, I found that the blood, before it left the slaughter-houses, was beaten or stirred with a bundle of twigs to remove the fibrin. This was the practice I found at Hereford, and there I was informed that the defibrinated blood was purchased by cider merchants, probably for some clarifying purpose. At Glasgow where the blood at the public abattoirs is similarly defibrinated, the blood after having been thus treated is purchased for an establishment where it is prepared for use by Turkey-red dyers. The object of the process carried on at these works appears to be to bring the liquid blood to a uniform consistence, and to a definite strength, by judicious dilution with water. The building in which the operations are conducted is a long shed or roofed building open only at one end (that furthest from the part where the principal operations are conducted). At the furthest end of the shed is situated a large tank, the top or cover of which forms a platform on to which the casks containing the blood are first of all hoisted. In this platform are trap doors leading to the tank below. Over one opening in the platform there is placed an inclined metal strainer into which the blood is first emptied directly from the cask. The more liquid part of the blood runs through into the tank beneath, while all portions of loose clot in the contents of the cask are arrested. This loose clot is collected in a tub, and, when a sufficient quantity of it has been collected, it is rubbed or broken down with water in a sort of mill or comminuting machine and run through the strainer into the tank. A sufficiency of water is mixed with the contents of the tank, which are then run off by a tap below into casks for sale. The floor below, on which these casks are placed to be filled, is paved, and underneath the pavement is a kind of cesspit or receiver partly open, for collecting such of the prepared blood as may be spilt. The blood as it arrives in the casks and as given out from the works is commonly in a state of commencing or advanced putrefaction, and stinks horribly.

Process observed at Glasgow.

At one time, as I am informed by Dr. Russell, the Health Officer of Glasgow, these works were a source of much trouble to the authorities on account of the effluvium nuisances proceeding from them. The stink was a subject of serious complaint at a distance as great as 150 yards, and it is still complained of occasionally. Beside the ordinary functional disturbances of nausea, loss of appetite, &c. produced by the noxious effluvia, I met with one person who assured me that exposure to them produced in him on several occasions attacks of diarrhœa which lasted for some hours. He very distinctly referred these attacks to the operation of the foul effluvia which entered his house from these works.

Effluvium nuisances.

Improvements with a view to lessen the nuisance have been in great measure effectual. Near the part of the works where the processes are chiefly conducted, and again between this part and the entrance, a wide pipe has been laid along the roof, where the pipe opens downwards by a funnel-shaped aperture. This pipe leads to the ashpit of a furnace fire, provided for this sole purpose, having a chimney shaft about 100 ft. high, and a fan is provided in the course of the pipe to draw the air out of the works and to drive it through the fire. The efficiency of the arrangement would of course greatly depend upon the carefulness exercised in

Mode of abatement of nuisances.

keeping up the fire; but at the time of my visit it was duly alight, and the fan was acting so efficiently that no offensive smell was perceptible within the building, except at the part where the principal operation was being carried on, and none outside.

Manufacture of Blood-Albumen.

The Manufacture of Blood-Albumen.

Nature of the business.

This trade consists in the separation of the serum from blood-clot, and the drying of the former into transparent flakes of a reddish yellow colour, but varying in depth of colour according to the quality of the serum from which they are made. It is a trade which I believe has only risen up within the last quarter of a century. At the present time it is pretty extensively carried on in many places. Two firms alone, viz., that of King & Co. and that of Smith and Forrest, have each of them establishments in many of the large towns in the kingdom.

Process.

Blood-clot is absolutely worthless for the purposes of this trade if it be not fresh. The more recently the blood has coagulated the more valuable it is for albumen making. Hence the blood-albumen makers make arrangements for the speedy collection of blood from butchers and town abattoirs, and it is dealt with immediately on its arrival at the works. Sometimes the first process, that of "separation" of the serum from the clot, is carried on in some part of a public abattoir. This is the case at Deptford, Croydon, Glasgow, &c. The serum is, in such cases, sent away in casks to the establishments where it is dried.

The blood arrives in the shallow iron vessels in which it is caught from the slaughtered animals, or in casks. The clot is immediately taken out and carefully sliced, (when it arrives in shallow vessels it is sliced before removal from them,) and the slices are arranged upon iron strainers, each with a pan beneath to receive the serum which flows out as the clot continues to contract spontaneously. The season of the year governs the time during which this draining is prolonged. In the summer it is continued for about 12 hours, but in the winter for 18 or 24 hours. The strainers, each with its pan beneath, are arranged on racks in a building which is so constructed as to be kept as cool as possible. It is also important that the building should be in such a locality as to be free from vibration caused by the passage of heavy vehicles or railway trains. From the pans the serum is, in the best works, transferred into a settling tank, where it remains about two days, until all the red colouring matter, &c. which may be in suspension have been deposited. At some works, where an inferior article is made, the highly-coloured serum which comes with the clot in the casks is dried, and, after the clot has been drained, it is put into a cask from which the head has been taken out to separate in bulk still further, and the dark serum which exudes is run off for use.

The serum is then transferred into a series of shallow iron trays, which are arranged upon racks in a chamber heated with steam pipes to a temperature of about 120°.

When it is quite dry and brittle, the albumen is scraped from the trays and taken to the warehouse to be sorted and packed.

The waste clot usually is sent away either to the manure maker or to the blood driers, but is sometimes dealt with on the spot.

Effluvium nuisances.

The well-known faint odour of blood always pervades an establishment of this kind, and is especially marked in the drying chamber, but it does not pass beyond it in any such way as to cause a nuisance, unless the manufactory be very badly conducted. Still from time to time such an establishment has become a nuisance. When I was Health Officer in Islington I had, on more than one occasion, to deal with establishments of the kind, on account of repeated complaints of nuisances from them. Similar proceedings, I am informed, have been found necessary elsewhere.

I myself have observed no ill effects upon health occasioned by the effluvia, nor have I heard of any produced elsewhere.

Sources of nuisance.

The two ordinary sources of nuisance from blood-albumen works consist :—

1. In the effluvia of putrid blood arising from the exhausted clots retained on the premises prior to removal.

2. In the general disagreeable faint smell proceeding from the yard and premises, especially when due cleanliness is not observed.

3. In effluvia from other and further processes, such as blood boiling or blood-manure making, carried on upon the premises.

In one instance, in my experience, complaints were made of an establishment in Islington, the cause of the nuisance being the evolution of ammonia in the drying process. This was a good many years ago; and I found it resulted from the use of an ammoniuret of copper, which at that time was added to the serum before drying. I visited this establishment again during this inquiry, and was informed that the use of the ammoniuret had long been discontinued, no advantage having resulted from it.

As to the remedies for nuisances :—

Modes of preventing nuisances.

1. It is a practice in some works to throw the exhausted clot into a clot-bin where it is left until removal. But now, in the best works, the clots are at once put into moderately sized casks through a sufficiently large opening at one end, which, when the cask is full, is closely fastened down with a cover secured by screws.

2. Such works as these require to be conducted in a very cleanly manner. The yard should be well paved with stone, set so that no water may lodge upon it, and so that any offensive liquids that may reach it may not form pools, but flow readily away to the drain inlet. It should be kept at all times well swept up, and should be daily washed down with water. The separation room and the room in which the clots are sliced, when very near inhabited houses, should be closed in on all sides and ventilated at the roof, as recommended for slaughter-houses, and they should be well and evenly paved. The best kind of pavement that I have seen in use for such a room was one of cement. Flagstones are apt to crack or loosen, and the pavement to become uneven and thus liable to retain pools of liquid matters, or to the insinuation of these liquids between and beneath the stones. Nothing can be more objectionable than a wooden floor, such as I have seen in use at Leeds. The floors should be frequently scrubbed and cleaned, all the vessels and implements used ought to be regularly cleansed, and the whole interior of the buildings periodically lime-whited. The vapours from the drying chambers should be discharged at an elevation greater than that of adjoining houses.

The Manufacture of Blood or Blood-Clot into Manure.

Manufacture of Blood Manure.

The conversion of blood or blood-clot into a blood manure is effected by the use of an acid (which is almost invariably brown sulphuric acid), and subsequent drying. In only one instance have I seen hydrochloric acid used.

Processes as observed.

The process will be best understood by describing what I observed at two works in different places, in one of which fresh blood is used, and in the other blood-clot from an albumen factory.

1. At Cole's works, near Calne.

1. At Cole's blood-manure factory near Calne fresh blood is received from the large bacon factories in Calne. It arrives in a large cask laid upon its side on a framework upon wheels, and so arranged that the hindermost end can be tipped a little upwards. The cask contains about three hogsheads of blood. On the upper side is a circular opening about 8 inches diameter, having a rim and gutta-percha washer on which an iron plate or cover can be secured by means of screws. At the fore end is a discharge opening about 4 inches diameter, and a short pipe fitted with a slide valve. The blood is run in by the upper aperture. On arrival at the works the contents, which at my visit were still warm, are stirred through the same aperture with a stick, and then the slide valve of the discharge pipe being raised the contents are run out into a wooden tank, which they fill to about two thirds of its capacity. Brown sulphuric acid is then added and stirred with the blood until it coagulates to the consistence of thick mud. The tank being open this stirring is done by hand. The mixed material is then dug out and transferred to a bin roughly constructed of boards or wattles, which allow liquid matters to drain out and run over the floor of the works to sunken tanks provided for their reception. This liquid is used up in future operations. The material is then dried spontaneously. To allow of this there are erected outside the works, and at a height of about one foot from the ground, wooden floors on which the material is spread out. They are covered by a roofing which is capable of being moved from one part to another of the framework which supports it above the floor ; and three are wooden sides attached by hinges to the floor below, by means of which the floor can be shut in all round, or at either end, as may be requisite to meet varying conditions of the weather. The material dries in about three or four days in summer, but takes longer to dry in the winter. When dry, it is sold off or mixed into a manure with other materials, such as scutch manure, the ashes of burned tan, or superphosphate made on the premises. The establishment is situated in a very isolated spot far away from any dwellings. Formerly, that is to say, until within the last six years, it was a very serious nuisance, complaints of which were made by persons residing as far off as a mile from the works, and by persons travelling along the high road. The cause of the nuisance was the drying of the mixed material by artificial heat upon a heated floor or kiln. When this was given up, and spontaneous drying substituted, the nuisance ceased.

Formerly a nuisance.

Mode of abatement of nuisance.

2. At King's works at Bristol.

2. At King's blood albumen works near Bristol, the blood-clot from the works is converted on the premises into manure. On these premises there is a building with louvred sides all round (formerly in use for glue-making), and the floor of this covers a part of the open yard. The clot is laid on the stones under the shed thus formed, brown sulphuric acid is added to it, and the whole mixed together by hand. At the time of my visit a large heap of the mixed material lay at in this situation, where it is left to coagulate throughout and to drain, the acid bloody-looking liquid draining out passing across the yard to a drain inlet. After thus lying in a heap for about a month the several portions of clot have usually become sufficiently solidified throughout to permit of the material being dried. This driyng is effected, sometimes by spreading it on a steam chest about 3 ft. square, and sometimes by spontaneous drying upon the floor of the covered building, or on racks or nets within the

building. The Medical Officer of Health tells me that serious complaints of nuisances from these works have been made.

At Hyland's blood albumen factory at Belle Isle some of the clot is converted into a kind of manure by first comminuting it in a mill, and then by hand labour mixing with it powdered alum in small quantities at a time.

Effluvium-nuisances.

The mixing of blood with acid gives rise to a sickening vapour which under ordinary circumstances may be a source of nuisance. The drying process especially, if conducted by heat without due care and precaution, is also liable to create a nuisance.

Mode of prevention of nuisances.

The mixing with acid should be conducted in a close vessel, the vapour from which should be conducted through a fire, and the drying, if effected by heat, should be carried out in the manner recommended below.

Blood Drying and Blood Boiling.

Blood Drying and Blood Boiling.

Processes as observed.

The drying of blood-clot (the refuse of albumen makers) and of blood in a condition unfit for use by albumen makers, is now commonly effected upon a tiled floor heated by flues underneath, the floor being protected by a roof of some kind, or situated within a building. In a few instances, as for example at Walshe's factory at the Manchester abattoirs, the drying is effected by laying the clot upon a floor formed by a steam chest. By the latter method, however, the blood is dried more slowly than by the former. "Blood boiling" is a process now almost obsolete; it appears for the most part to have been replaced by albumen making and clot drying. Nevertheless I have seen it in operation in two or three places. It is conducted either by throwing free steam into the blood or by boiling the blood in a large pan furnished with a fire beneath. The steam boiling may be seen in operation at Hempleman's manure works at Stratford, and at Hale's small works near the South Bermondsey railway station. The blood is first mixed with water and, after boiling, the watery liquid is separated from the coagulated mass first by straining and subsequently by pressure. The coagulated residue is dried on a kiln heated by a fire beneath, or sold in the condition in which it leaves the press. The only place at which I have seen blood boiled in a pan by means of a fire beneath, has been at Forrest's albumen works near Paisley. The foreman told me that the blood was boiled until it was nearly dry.

Effluvium-nuisances.

All these processes are necessarily offensive if the blood used be in any degree putrified, and if due precautions be not used to arrest and properly dispose of the offensive effluvia. The offensiveness is least when the blood or blood-clot is fresh and when steam is used for boiling and drying. It is apt to be very great, and the nuisance may be perceptible at a long distance from the works, when fire heat is used for boiling or for heating the drying floor. The offensiveness is then due in great measure to the partial charring of the blood, either in the pan or on the kiln, a result which it is nearly impossible to entirely provide against. For this reason all processes of boiling and drying ought, in populated localities, to be effected by steam heat, which is more readily regulated than fire heat, and the steam and vapours should be discharged at a sufficient elevation. Moreover, to provide against occasional nuisance in the event of putrid blood being dealt with, there should be means of condensing the vapours that arise, and conducting such as fail to be condensed through a fire.

Mode of preventing nuisances.

GUT-SCRAPING, GUT-SPINNING, PREPARATION OF SAUSAGE SKINS.

Establishments visited.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 4, 1875	Link - -	Whitechapel.	
„ 5 „	Tracey - -	Belle Isle.	
„ „ „	Edwards - -	Do.	
„ 23 „	Neville - -	Tottenham.	
Dec. 11 „	Potier - -	St. George's Southwark.	
„ „ „	Curtis - -	Do.	
Jan. 5, 1876	Ford - -	Railway arches, Rotherhithe.	
June 14 „	Garner - -	Clayton, Manchester.	
„ 15 „	Schlater - -	Salford.	
Aug. 16 „	Spencer - -	Cheltenham.	
Dec. 4 „	? - - -	Glasgow.	
Jan. 11, 1877	Poulton - -	Kingston, Portsmouth.	
„ 29 „	Day - -	Reading - -	Slaughtering, bacon curing.
„ 30 „	Thomas Harris -	Calne - -	Do.
Feb. 6 „	C. Harris - -	Do. - -	Do.
Mar. 15 „	Coulson - -	Cambridge -	Slaughtering.
„ 28 „	W. & C. Forrest -	Bredilaud, Paisley-	Blood boiling and albumen making.

Nature of the business.

"Gut-spinning" is the twisting of prepared gut into cord of various diameter for various purposes, *i.e.*, for ordinary catgut, for use in machinery, and for fiddle-strings. Hence in different establishments articles of different fineness and coarseness are prepared, from the most delicate fiddle-string to a thick catgut cable. Sometimes all these varieties are made in the same establishment. The first operation, however, in every instance is the "gut-scraping." For sausage skins the manipulation of the gut ceases here.

Material used.

The gut used for the above purposes is the small intestine of sheep and hogs. It is said that the sheep's small intestine measures 25 to 30 yards, and the hog's about 20 yards. The guts are collected from butchers, and in some establishments they are received from the country, or, packed with salt in barrels, from Ireland. In some establishments dried guts previously scraped are received from abroad for further manipulation. For fine purposes, such as the making of fiddle-strings, only the best and freshest guts from the butcher can be used, but for coarser purposes their condition as to freshness is less material, and sometimes they arrive at the works in an offensive condition. The scraping is more easily effected when the gut is not quite fresh.

Process.

The first operation in gut-scraping is to get rid of the contents of the gut. For this purpose it is thrown into a tub of water, by which a man sits, and passes the gut between his fingers into another tub of water, pressing the contents along the cavity as he proceeds. In some works water from a tap over which an end of the gut is slipped is run through the gut. This is repeated several times until the gut is quite clean. At Mr. T. Harris' at Calne, the guts are then placed in brine for eight or ten days, and then for three or four days in cold water.

Scraping.

The process of scraping is, in the larger establishments, performed by women. A bench or table is provided, at which a woman sits and scrapes the gut with a wedge-shaped piece of wood as she passes it along the table before her. In some places I have seen the back of a knife used for this purpose. By this process all the interior softer parts are detached and pass along the gut to the end, where they are discharged, the peritoneum of the gut, and probably a little of the muscular layer, being alone left. It is again thrown into water.

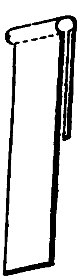
The further treatment depends upon the use to which the scraped gut is to be applied. When it is to be used for sausage skins, the scraped guts are simply packed in barrels with salt. Such as are intended for making catgut or fiddle-strings are treated further.

Spinning.

In some establishments scraped guts are dried for exportation. They are stretched over frames, dried in a chamber artificially heated, and then tied up in bundles. When dried guts are received they are soaked in water to prepare them for spinning.

For making ordinary catgut no further preparation is needed than sewing together lengths of scraped gut with a needle and thread. They then go to be spun by means of an ordinary spinning wheel. The number of strands of gut spun into a cord varies with the thickness of catgut required. Catgut of half an inch in thickness will have as many as 700 strands of gut in it. When a length of catgut has been spun, it is dried by stretching it over pegs and exposing it (protected in some way from the weather) in the open air. Before drying, however, it is customary to bleach it by stretching it upon a frame and putting it for about three days into a chamber where it is exposed to the action of the fumes of burning sulphur.

The preparation of fiddle strings is a very delicate operation, and, for the finest violin strings, requires the utmost care. The best scraped guts alone are used, and such as have any flaw in them are rejected. Each gut is treated separately. It is put into a clean earthenware pan containing a weak solution of carbonate of soda, and this solution is changed (a fresh pan being used each time) twice a day for seven or eight days, and, each time the gut is transferred, it is stripped through the ringed part of a strip of copper bent into the shape shown in the margin, the thumb being pressed upon the gut as it is passed through. After this treatment it is ready for spinning. The first strings of violins are made by twisting together three, or better four, such prepared guts.



Character of establishments.

Gut-scraping establishments vary very much in character. My first experience of the process of gut scraping was obtained many years ago in a dirty little room at the end of a little blind court of small houses at Belle Isle. This was a horrible little place, but I have since seen worse. For instance, when I was at Salford, Dr. Tatham, the Medical Officer of Health, took me to a place which had been much complained of. It was a small, low, dilapidated, wooden shed in a field, and close to an inhabited house and a roadway. The paving, such as there was, consisted of some loose stones, and in the centre was a kind of well or cesspit covered with some loose boards. Part of the drainage from the floor ran into this pit, which was the only water supply available, and part into a filthy little pond just outside the door. The immediate surroundings, where pigs and fowls were kept, were also indescribably filthy. Only sausage skins were prepared here. When I was at Bilston, the Health Officer showed me the late site of a similar workshop, the occupants of which had recently removed after proceedings under the Public Health Act. The work of sausage-skin making was carried on in a small washhouse in the yard at the rear of a pair of small houses in a side street. The yard was closely built in. Next the door of this washhouse was a filthy leaking cesspool privy. Happily all gut-scraping establishments are not like those which I have attempted to describe; but many of those devoted merely to the preparation of sausage skins, especially in large towns, are of this miserable character. Between this class of establishments, which are carried on by poor people, and the best kind of gut-spinning establishments, in which a fair amount of capital has been sunk, there are all grades.

Effluvium-nuisances.

Speaking generally of gut scraping and gut spinning establishments (I except a very few, such as those I shall mention presently), they are the most intolerable of nuisances wherever they may chance to be located. Within the workshops the stench is inconceivably horrible: few persons unaccustomed to it could bear to remain for a single minute in some scraping rooms that I have visited, and I myself have sometimes had a difficulty to restrain vomiting and to carry on the inquiries I was bent upon. The stench, after I have been in some of them for 20 minutes or half-an-hour, has so pertinaciously attached itself to my clothing and hair, that only repeated ablutions have removed the odour from my hair, and my clothing has retained the stench for days. It spreads from the workshop and yard all round the neighbourhood, and often gives rise to such loud complaints that local authorities in some towns have insisted upon entire removal out of them.

Effect upon health.

It would not be unreasonable to expect that where such putrid animal effluvia as proceed from gut-scraping establishments, pervade a neighbourhood, the public health in that neighbourhood would obviously suffer from them. But the several health officers I have questioned upon the subject have been unable to furnish me with any evidence, either that septic diseases prevailed more in such neighbourhoods than in other similarly peopled parts of their districts, or that there was more general sickness, or that zymotic diseases prevailed more, or were more fatal. It is quite possible (may I say probable?) that the opinion they gave me upon this point resulted from imperfect observation. But it is very certain that there is no trade among all those I have inquired into, which is more fruitful in inducing those minor and temporary disturbances of health which exposure to disgusting smells is apt to produce. There is no occasion for a person to be in any way delicate to predispose him to this result.

Sources of nuisance.

The sources from which nuisance arises in such works as these are too obvious, from the description which I have given of them, to require enumeration. I need only say that they may arise either from the premises themselves in which the work is carried on, or from deposits of refuse matters in inappropriate places or without due precautions being taken to arrest the offensive effluvia arising from them. I may, therefore, at once pass on to the mode in which I have, in some establishments, found these sources of nuisance more or less obviated.

Establishments described.

Perhaps the most satisfactory course will be to describe some of the larger works I have visited, commencing with one where the nuisance was very considerable, and then giving a description of some works where the nuisance has, I understand, been prevented.

Establishment in Whitechapel.

The first establishment I shall describe is situated in a narrow street of small houses in Whitechapel, and the entrance leads to a yard filthy and stinking. Water from the workshop was at the time of my visit lying in pools in the yard, and scrapings from the guts were littered about it; and there was an untrapped pipe drain opening, by which the more liquid refuse might find its way into the public sewer. The building, entered from the yard, consists of a ground floor and an upper floor, the ground floor being devoted to the scraping department, and the upper floor to the spinning and preparation of fiddle-strings (a common arrangement in gut-spinning establishments). The ground floor room was most horribly offensive. It was partly paved and partly boarded, but both imperfectly, and was everywhere excessively filthy from refuse matters long trodden in. The tubs and plant in this part of the premises were as uncleansed as the premises themselves, and the work was being performed without any proper precautions or care not to spill or let fall refuse matters upon the floor. The upper floor was cleaner, and the part where the guts were being prepared for fiddle-strings presented nothing objectionable beyond the all-prevading smell from the lower regions.

Tracey's establishment in Islington.

The next establishment I shall describe is that of Mr. Tracey, in Belle Isle, Islington. Here, again, there are two floors, the lower devoted to the scraping and the upper to the spinning and fiddle-string preparation. The buildings were erected for the purposes of this trade and all their arrangements have been directed accordingly. The yard was well paved, well drained, and clean, and the ground floor of the building was also well and evenly paved, clean, and free from litter. All that was required was some scraping and lime-whiting of the walls against which the scraping bench was situated. The offensiveness of this room was comparatively trifling: but little work was going on at the time of my visit. The upper floor was clean, tidy, and inoffensive. There was no nuisance observable outside the premises. It would not have been suspected by anyone that a gut-scraping establishment was there.

Garner's establishment at Clayton.

But the most perfect establishment, in its arrangements, which I have seen is that of Mr. Garner, at Clayton, Manchester. He formerly had works at Levensholme, from which place he was compelled to remove, it is said, on account of the nuisance they were to the neighbourhood. A great outcry was made when it became known that he was about to remove to Clayton, but, now that he is fully established there in his new works, the health officer tells me that no nuisance whatever is occasioned. He took me to the works with a view of showing them to me as model works of the kind. No work was proceeding on the day of my visit, but the arrangements of the workshops were clearly such as to conduce to salubrity and avoidance of nuisance. At these works all the workshops are upon the ground floor. The room devoted to the scraping is very well paved, capacious, and very clean, both as respects the walls, floor, and plant. Along the whole length of the shed, beneath the paving, there is a drain to carry off the liquid refuse of the shop; it is about a foot diameter and communicates, at the further end of the shop, directly with the ashpit of a boiler fire by means of an iron facing over the mouth of the ashpit. Hence all the air for the fire is derived from the drain. The drain openings in the shed are untrapped, and there is a good fall in the opposite direction to the fire towards the town sewers, between which and the workshop is interposed a manhole shaft, by which the drain can be arrived at outside the works, and cleared, if this should be at any time necessary. There is an unlimited supply of water from the neighbouring canal, so that a perpetual flow of water through the drain is provided for. Mr. Garner says he finds that, by this means, he can keep the atmosphere of the workshop comparatively sweet, air being drawn through it for the supply of the

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boiler fire by the untrapped drain openings, while the drain is kept clear by a constant flow of water. The spinning and drying are conducted under a long shed glazed at the sides along the whole length of 50 yards with sliding sashes, like a greenhouse, which are open in the summer, but in winter and damp weather are closed, and then the shed is artificially warmed for the drying of the catgut by a steam warming pipe carried along both sides near the floor.

Use of deodorants.

In none of my visits to works of this character have I seen any deodorants applied to such raw gut as comes to establishments in an offensive condition, or to such as has been left to soak until offensive for the convenience of ready scraping, nor yet to the offensive refuse of the process, for the purpose of destroying their bad odour. But that the use of a chemical agent for the prevention of putrefaction in the fresh guts is practicable, and practised successfully in some establishments in France, is shown by the following extract which I take from M. de Freycinet's report on Trade Sanitation,* the only work of the kind that I am acquainted with :—†

"Le nettoyage ou séparation de la membrane péritonéale dont une partie seulemente a été enlevée par le dégraissage á l'abattoir, s'exécute ordinairement à la suite d'une fermentation putride qui constitue un des détails les plus repoussants de cette industrie. Cette macération, dont la durée varie de huit jours à un mois selon la saison, a pour objet de décomposer en partie la muqueuse et de la rendre moins adhérente, afin que les ouvriers puissent la détacher sans risque de nuire à la qualité des boyaux. Quelques industriels commencent à adopter le procédé Labarraque, consistant à immerger les intestins dans une solution de chlorure de soude, ce qui dispense de toute fermentation putride. La fabrique de MM. Monnier et Dutripon, à Eysines (Gironde), remarquable d'ailleurs par l'ordre et la propreté qui y règnent, marche dans ces conditions depuis trois ans. Aujourd'hui quelques heures suffisent pour permettre d'effectuer le ratissage des boyaux."‡

The only place that I have visited in which an antiseptic solution is used is Mr. Coulson's sausage manufactory in Cambridge. Here it has been the habit for some time past, on the suggestion of Dr. Anningson, the Medical Officer of Health, to immerse the fresh guts for a few days before scraping them in a weak solution of chloralum. Mr. Coulson tells me that while this practice has eventuated in doing away with all nuisance, it has not injured the guts, nor rendered the scraping of them in any way more difficult.

Modes of preventing nuisances.

It follows from all that has preceded, that the essentials for carrying on this trade in a manner devoid of nuisance are :—1. A building specially erected or carefully adapted to the peculiarities of the trade, sufficiently spacious, and situated as far as practicable in a locality not closely built in. The chamber where any of the more offensive parts of the trade are conducted should have no direct communication with other rooms. It should be lighted either from the sides or roof with windows incapable of being opened, and ventilation should be provided for independently. It appears to me that the best mode of managing this would be to arrange for the drawing off of the foul air of the chamber continuously, and conducting it through a fire, or first through a screen of wood charcoal and then through a fire, and that the air for the supply of the room should be drawn from the outside through screens, or properly arranged boxes, containing wood charcoal, duly protected from wet and damp, and from time to time renewed, which when the room was shut up at night would serve to arrest the passage outwards of offensive effluvia. The inner walls to the height of about 6 ft. should be covered with some impervious material capable of being washed, such as smooth cement or sheet zinc. 2. The floor should be paved with an impervious paving, preferably jointless, and it should be properly sloped to a duly trapped drain gully. 3. There should be an unrestricted supply of water. 4. Scrupulous cleanliness should be observed in the conduct of the business. The floor should be kept constantly sprinkled with some deodorant solution, such as of carbolic acid or chloride of lime; no unnecessary litter should be allowed, and any that may be made should be frequently swept up, and, together with refuse matters and scrapings, should be deposited, with the addition of a deodorant, in appropriate vessels made of some impervious material, such as galvanized iron, and covered with covers of like material when not required to be open for use. At the close of each day's work the floor and walls to the height of the impervious portion should be washed down with water containing some deodorant, and all tubs, tables, benches, and utensils that have been in use should be similarly cleansed. The inner walls and ceilings should be periodically lime-whited. 5. All undried gut brought upon the premises should be brought in closed impervious vessels, which should not be opened except in the chamber where they are to be manipulated, and all refuse matters should be removed from the premises daily in the closed vessels in which they are deposited. Any gut which arrives in an offensive condition should at once be placed in a deodorant solution; and some antiseptic solution should (as appears to be practicable) be used for the soaking even of fresh guts on their first arrival. 6. Great care should be taken in dealing with the refuse matters after removal from the premises. If deposited anywhere upon land the matters should at once be covered over with a layer of fresh earth. At Mr. T. Harris' at Calne, where the nuisance from the deposit of refuse in his farm premises was at one time intolerable at a distance of several hundred yards, the nuisance has, without altering the position of the deposit, been obviated. A wall of straw litter is made, enclosing a space within which the refuse is thrown, and the offensive matter is immediately covered up with dry earth and ashes: this building up of the wall and deposit of refuse and earth is continued until a sufficient mound is raised. When it becomes necessary to remove this as manure, it is removed inoffensively. Such a stack as this should, however, be protected from the rain.

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* The title of the work is, "Rapport sur l'Assainissement des Fabriques ou des "procédés d'industries insalubres en France, Angleterre et dans la Belgique et la "Prusse Rhénane, par M. Charles de Freycinet. Publié par ordre de son Excellence "M. le Ministre de l'Agriculture, du Commerce et des Travaux publiques. Paris: "Dunod, 1866."

† I must, however, except Dr. Waller Lewis' "Report on the Laws and Ordon-"nances in force in France for the Regulation of Noxious Trades and Occupations." [Presented to both Houses of Parliament by command of Her Majesty.] 1855.

‡ M. de Freycinet adds—"Le conseil d'hygiène publique de la Gironde est telle-"ment convaincu de la supériorité de ce procédé, qu'il le rend maintenant obligatoire. "Ainsi un arrête du juin 1864, relatif à la boyauderie de Madame Veuve Chrétien, "porte la clause suivante: Art. 10. Lorsque les boyaux auront été degraissés et "retournés, on emploiera du chlorure de soude à 12 ou 13 degrés à dose de 1·500 "grammes dans deux ou trois seaux d'eau pour un tonneau renfermant les intestins "grêles de 50 bœufs."

Bone-boiling and Bone-size Making.
Establishments visited.

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Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Broach - -	Belle Isle.	
Dec. 11 „	Abel - -	St. George's Southwark.	Stuff-melting.
„ „ „	Hoare - -	Do.	Do.
Jan. 5, 1876	Torr - -	Deptford - -	Manufacture of animal charcoal and sulphate of ammonia.
„ 11 „	Gabriel Scott -	Nursling, Southampton.	Manufacture of artificial manure.
„ 21 „	G. Lockyer and Sons.	Bristol - -	Manufacture of animal charcoal and sulphate of ammonia.
„ „ „	H. & T. Proctor -	Bristol - -	Manufacture of artificial manure.
Feb. 23 „	Harris - -	Stratford - -	Fat-melting.
„ „ „	Seaborne - -	Do. - -	Do.
„ 24 „	Hunt -	Bow Bridge -	Manufacture of artificial manure.
Mar. 20 „	Morris and Griffin	Wolverhampton -	(Steaming), manufacture of artificial manure, and sulphuric acid.
April 26 „	Walker - -	Nottingham.	
„ „ „	Hall - -	Do. - -	Potted meat making, size making.
May 13 „	Packard & Co. -	Bramford, Ipswich	(Steaming), manufacture of artificial manure.
„ 16 „	Vickers and Son -	Manchester -	Manufacture of size, soap, and manure, &c.
„ 17 „	S. Smith - -	Do. - -	Bone button making.
June 1 „	Phillips - -	Leeds - -	(Bone steaming), manure making.
Nov. 16 „	E. Cook - -	Bow Bridge -	Fat - melting, soap making.
Jan. 10, 1877	? - - -	Near Portsmouth -	Pig-keeping.
Feb. 13 „	Proctor and Ryland.	Birmingham -	Manufacture of artificial manure.
Mar. 26 „	Burrell - -	Newcastle-on-Tyne	Do.
„ 28 „	J. Poynter and Son.	Greenock - -	(Steaming), manufacture of animal charcoal and sulphate of ammonia, making, &c. manure

Kinds of establishments where bones are boiled.

Butchers' bones, bones of horses and domestic cattle, and domestic refuse bones from the stores of what are called "marine store dealers," are boiled in several kinds of establishments with a double object, viz., 1st. For the extraction of the fat they contain; 2nd. To prepare the bones for further trade applications. Hence we find bones boiled in establishments where nothing but bone-boiling is carried on, or where only the rendering of butchers' fat or kitchen stuff is conjoined with it; in soap works, manure works, knackeries, manufactories of bone buttons, &c., animal charcoal manufactories, dripping-makers' establishments, or establishments for size making, &c. In some of these places any bones are boiled indiscriminately; in others only bones of a selected kind are boiled. Equally varied is the extent to which the process is applied in different kinds of establishments. In bone-boiling establishments *par excellence* 20 or 30 tons are boiled in the course of a week. In some small establishments, where selected bones are boiled in preparation for some special future application of them, only a ton or two, perhaps, are boiled in the course of a week. Hence, too, it arises that the mode of boiling and the duration of the boiling differ in different establishments, and that in some a process of steaming under pressure is preferred to one of boiling, as on the whole more suitable.

Process.

Bones are not often boiled in the open air. The process is usually conducted under a shed or within a closed building. They are usually boiled in large iron pans or boilers, or tanks; sometimes quite open, at other times provided with a lid. Heat is applied either by a fire beneath the pan or by perforated steam pipes introduced to the bottom of the pan. The long bones of the larger animals which contain marrow are first sawn through, usually with a circular revolving saw, so as to separate the ends from the shank and to open the central cavity containing the marrow. Sometimes the shanks are split with a hatchet or sawn along their whole length. Shorter bones and flat bones are usually simply sawn across. When the boiling has been carried far enough, and all the fat is believed to be extracted, the fat is skimmed off.

Thus far the process is similar in all works where bones are boiled in boilers or tanks. But the duration of the boiling is not always the same. Where the object is merely to extract the fat from the bones and to prepare them for bone-manure making, a few hours' boiling suffices; but when there is in view the further object of making size from the bones, the boiling is, with occasional additions of water as it boils away, continued for four or five days and nights. The subsequent dealing with the boiled bones and liquor also varies with the object in view. Thus at the ordinary bone-boiling establishments it is customary to discharge the boiled bones into a brick chamber, which is termed the "bone-hole," where they lie, and in time become dry by a process of spontaneous heating. They remain there until the bone-hole is filled and requires emptying. The bone-hole is usually sufficiently capacious to hold a week or ten days' working, sometimes more. When bones are boiled at manure works or at soap works it is common to dry them in a chamber by the same process.

The best long bones are, after boiling, reserved for making bone buttons and bone handles of various kinds; and to preserve their white colour they are thrown into a tank of cold water as soon as they are taken from the boiling pans.

At ordinary bone-boiling establishments the residual liquor, although containing more or less gelatin, is run off into the drains. But in establishments where size is made, the gelatinous liquor, obtained by the prolonged boiling, is drawn off by a tap from the lower part of the boiler, and is subsequently boiled down to the requisite consistence, either in the same or another similar boiler, from which it is usually drawn off into casks for sale.

Effluvium-nuisances.

Bone-boiling, as ordinarily carried on in large bone-boiling establishments, is often a cause of considerable annoyance to the neighbours. In small establishments where fresh butchers' bones are used for making dripping, or where heads of oxen are used for making potted meat, and the bones are subsequently boiled for size making, the nuisance is at its minimum. But large establishments where several tons of bones are boiled daily for subsequent use in manure making, or to obtain fat for

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Sources of nuisance.

The sources of nuisances from bone-boiling establishments may be one or more of the following:—

1st. The reception and retention on the premises, especially in the open air, of stale or semi-putrid bones, such as are supplied from marine store dealers, who purchase them in driblets from private houses in London and other large towns, and themselves retain them until a sufficient bulk has accumulated to render it worth while to send them away.

2nd. The process of boiling. Where fresh bones from the butcher are boiled, the steam which issues has merely a brothy odour, which, although not nauseous, is sufficiently unpleasant, if pretty constant or if it is frequently blown by the wind into the windows of adjoining dwelling-houses. But when the bones are stale or putrid, a nauseous character is added to the smell, which may then travel with the wind to a considerable distance. This putridity of the bones and vapour is more likely to happen in the summer time than in the winter season, and it is in hot weather that such a smell as this is least readily tolerated. Similar steam is given off when the charge of boiled bones is removed hot from the boiler.

3rd. But the principal source of nuisance in ordinary bone-boiling is the effluvia from the bone-hole. When recently boiled bones are heaped together they heat from superficial decomposition, and large volumes of steam having a very offensive musty ammoniacal odour rise from them. This steam fills the bone-hole or chamber to such an extent that it stings the eyes and nostrils of a person entering it, when bones have been lying there for a week or longer. The vapour escapes from the roof, which is sometimes furnished with a skylight which is opened to permit its escape, or from louvres provided for the same purpose. This offensive effluvium travels farther, and is usually more seriously complained of than that from the mere process of boiling.

4th. I heard of one small establishment where bones are boiled for size, and subsequently thrown into cold water, which had in the summer time been made the subject of complaint by the neighbours, on the ground of the offensive smell issuing from a drain down which some liquid from the works had been cast. It was found that the source of the nuisance was the discharge into the drain of the cold water in which the bones had been soaked or cooled, and which had been allowed to stand until it had become putrid.

With the exception of the occasional production of the series of temporary functional disturbances referred to in the introductory part of this Report, such as nausea, loss of appetite, a sense of depression, and headache, I have not been able to discover that any serious effect upon health has been occasioned by exposure to the effluvia from bone-boiling establishments.

Modes of preventing nuisances.

As respects the mode of preventing or minimizing the several nuisances which may arise from bone-boiling works:—

1st. The nuisance arising from the reception and storing of stale and semi-putrid bones may be obviated by their transmission and storage in tarred bags or other closed receptacles, and by their utilisation as speedily after reception as may be; or if the bones are placed in a heap in the works, they may be in great measure prevented from being a nuisance by covering the heap with a tarpaulin.

2nd. The steam from the boilers is a nuisance very much according to the elevation at which it is discharged. When discharged at a considerable height it rapidly diffuses itself, and does not usually fall to the ground in a sufficiently dense form to create a nuisance. Hence, where practicable, one mode of preventing this nuisance is to boil in a closed boiler provided with a channel or flue to conduct the steam into a sufficiently tall chimney shaft. At many of the works I have visited the boiling, formerly effected by means of a fire under the pan, is now effected by means of free steam, and it is said that the alteration has resulted in a diminution of the nuisance. The best boiling arrangements I have seen are at Vickers' soap and manure works, at Miles Platting, Manchester. Messrs. Vickers are very earnest, and take an interest in endeavouring to carry on their offensive trade without creating nuisance. At these works they make bone size, so that the boiling of each charge is prolonged to four days and nights. The following description of their plant and arrangements may therefore be useful. The bones which they receive are principally from the butchers, marine store dealers, and horse slaughterers. The bones first undergo a rough crushing. The boilers consist of five square, covered, wrought-iron vessels, each capable of boiling about 12 tons of bones at one charge. They are arranged in a bank. Each boiler is provided at the top with an opening in the cover, about 3 ft. diameter, which opening during the boiling is closed by a door or cover. A sufficient quantity of water is added to the bones, and the boiling is effected by close steam. At the end of 15 hours' continuous simmering the fat, which by that time is extracted, is removed. The steam is shut off, sufficient water is added to bring the fat which floats on the surface to near the top of the boiler, and it is ladled out through the charging opening. This removal of fat is repeated after a further six hours' simmering, and then the boiling is commenced for the extraction of the gelatine. When the boiling is completely finished, that is to say, after three or four days and nights continuous boiling, the liquor is run out by a pipe and tap from the lower part of the boiler into another similar boiler at a lower level, heated in the same way, and here it is boiled down to the required consistence for size. It is then run off by a pipe into shallow iron vats, which are 8 or 10 inches deep, to cool and gelatinise. This size, it is said, is that used by dyers, and for stiffening calico goods. No alum is used, since it would render the size, it is said, unfit for the use to which it is to be applied. The charge of boiled bones, after running off the liquor from the first boiler, is drawn out by an opening in the side of the boiler, which during boiling is kept closely fastened up by a door fitting accurately and secured by some clamps. The steam from both the bone-boilers and the size-evaporating pan is carried off by a wide pipe fitted to the cover of each, and communicating with a flue which, after passing by the end of the flues from the steam boilers, conducts it, together with the highly heated gases from these flues, into a chimney stack 210 feet high. The draught from this chimney is sufficiently great to cause a strong in-draught into the boilers whenever any of them are opened. The bones are drawn hot from the boiler, and are conveyed to a bone shed in another part of the premises. More or less disagreeable steam must be given off during this part of the process; but the sheds and buildings are very capacious and lofty, so that any steam diffused through them from this cause is well diluted before it reaches the outside atmosphere in the street. The steam from the actual process of boiling, however, is thoroughly disposed of. At these works about 80 tons of bones are boiled per week.

Description of Vickers' establishment at Manchester.

At Hunt's bone works, at Bow Bridge, the boiling is effected by free

Method at Hunt's works at Bow Bridge.

steam in long open tanks arranged in a lofty chamber, which is closed up, and the vapours discharged into it are drawn off (as also from the chamber where the boiled bones heat and dry and from all other parts of the works) by means of a powerful fan, and are passed together with the rest of the vapours, first, through a shower of water and then through a fire, on their way for final discharge by a tall chimney shaft. This, too, is very effectual, and moreover obviates any nuisance from the discharge and drying of the boiled bones.

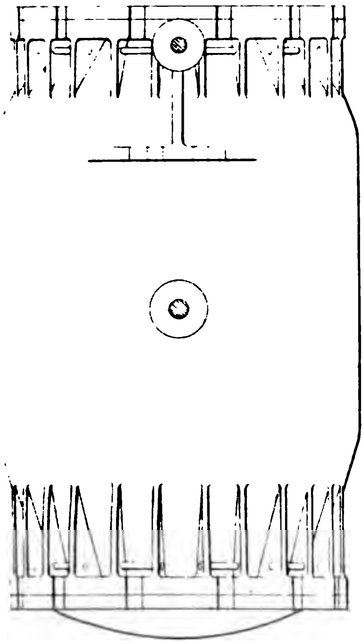
Passing vapours through a fire.

In small establishments where a fire under the pan is used, and no tall chimney is available, endeavours are often made to lessen the nuisance by covering the pan or boiler with a wooden cover, or close-fitting hood, having a portion in front hinged so that it can be raised for observation of the process, or for stirring the contents of the pan or removing fat. From the space between the boiler and the cover or hood, a flue conducts the steam into the ashpit of the fire beneath. The ashpit is provided with a close-fitting door, so that all the air required by the fire must enter beneath the lid, pass over the surface of the contents of the pan and carry the steam with it through the fire to the chimney. This arrangement, which is similar to that described and figured as in use for fat-melting (Fig. 4, p. 203), sometimes answers the required purpose pretty well, but the difficulty I have experienced with it in my own former health officer's district at Islington has been that of ensuring its proper use. Unless the master's eye is continually on his workmen, they are apt to leave the ashpit door open to improve the draught (as they fancy), or they allow the ashpit and the space in which the door moves to become choked up with ashes, or they take or break off the door altogether. Other dilapidations also readily occur and wholly destroy the efficiency of the apparatus. This arrangement is too much under the control of the workmen. Besides there is no provision against nuisance when the charge of boiled bones is removed. At Harris' establishment at Stratford, where free steam is used, the boilers are covered and the steam is drawn off by a fan to the boiler fires. As a remedy for the nuisances sometimes arising, although only temporarily, from the discharge of the hot boiled bones, it has occurred to me to suggest that in some cases the bones might be left to cool in the pan for a time before discharge, or that an extension of the practice (adopted in the case of the best shank bones) of throwing them into cold water might be practicable. But there may be practical objections to both these suggestions.

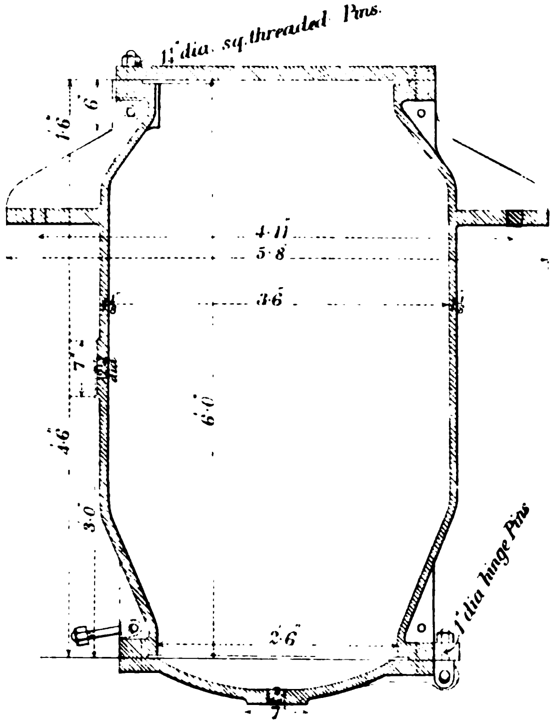
Bone-steaming.

The practice of extracting the fat from bones by steaming instead of boiling them is adopted at some works. While this is applicable to the requirements of some establishments, as for instance, where the bones are required subsequently for manure making, it is clearly not applicable to all establishments where bones are now boiled, on account of the condition to which the bones are reduced. This method is in use at Morris and Griffin's works (superphosphate works), at Wolverhampton, and at Packard's superphosphate works, Bramford, Ipswich. At Morris and Griffin's the steamer (Plate 8) consists of a strong iron cylinder 6 feet long by 3 feet 6 inches in greatest width. The bones are introduced at the top and removed at the bottom by hinged doors, which are closely fixed down during the steaming. Superheated steam (about 286° Fahr.) is thrown in, and in the course of 40 minutes all the fat is extracted. The steam is then shut off, and the steam remaining in the boiler is let off into a condensing chamber. Half an hour later the fat is drawn off by a tap at the bottom of the cylinder. The door at the bottom of the cylinder is opened and the bones are allowed to fall upon the paved floor below. As the bones cool they are seen to be covered with a sort of varnish of gelatin.

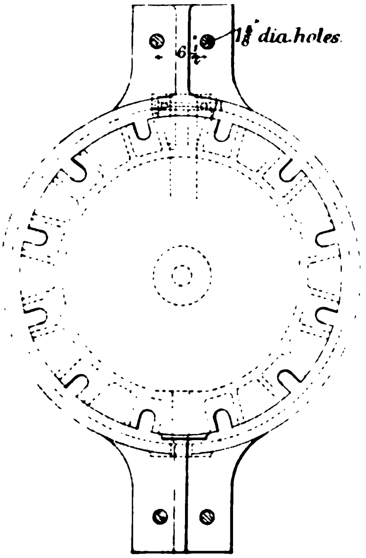
Plate 8.



FRONT ELEVATION.



VERTICAL SECTION.



PLAN.

BOILER

FOR

FULLER'S PATENT PROCESS.

Scale ½ Inch to the Foot.

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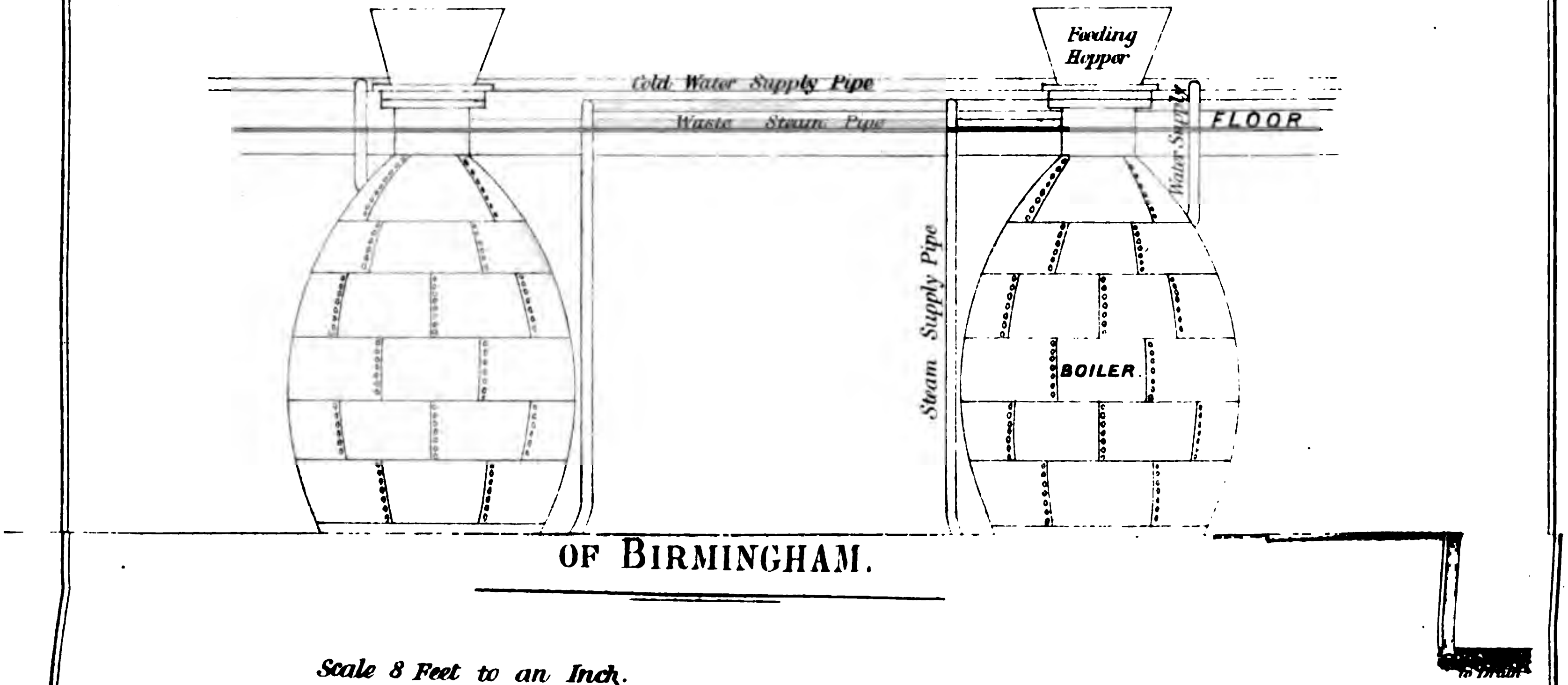

OF BIRMINGHAM.

Scale 8 Feet to an Inch.

[illegible] Bedford [illegible] Covent Garden

They are much more brittle than bones boiled in the ordinary way, and are more easily ground. They are in a condition to grind immediately, so that the bone-hole or storing chamber is dispensed with. Several obvious advantages attach to this process. At these works the cylinder is capable of steaming at one charge 2 tons 6¼ cwt. of bones, which yield 87 or 88 lbs. of fat to the ton. This apparatus was the subject of a patent by Mr. Fuller, of Morris and Griffin's works (No. 893, March 29, 1865).

Method at Proctor and Ryland's works, Birmingham.

At Proctor and Ryland's manure works in Birmingham a strong iron cylinder is in use, in which the bones are first boiled with water by means of free steam thrown in for the extraction of the fat, and subsequently steamed for the extraction of gelatin. (Plate 9.) There are two such cylinders, each capable of boiling at one time six or seven tons of bones. At the upper end of the cylinder is a short neck surrounding the charging opening which is capable of being closed down with a close-fitting cover, and at this part the steam pipe which descends to the bottom of the cylinder enters, and the waste steam pipe passes out. At the lower part of the cylinder is a wooden false bottom to support the bones, and opposite to it on one side a man-hole (with close-fitting door) by which the boiled bones are finally removed. Entering at the side there is a pipe by which cold water can be thrown in from a cistern above; and at the bottom there is a pipe for drawing off liquid matters. This pipe has two branches with appropriate taps; one branch leads to a drain and the other to a tank. The bones are first boiled with water by the agency of free steam; when sufficiently boiled the steam is turned off and time is given for the fat to separate, and then cold water is thrown in below to raise the fat to the level of the charging opening, where it is run down a pipe into a receiving vessel below. The water is then run off into the drain, the top cover fastened down again, and the bones are steamed at a pressure of about 50 lbs. to the inch for extraction of gelatine. After some hours the gelatine is run off into a tank and the bones are drawn out by the man-hole near the bottom of the cylinder. All waste steam is passed off by a pipe above, which after a long course through the works (during which course some of the steam becomes condensed), dips some 18 inches into an underground tank of water—the same tank which will be described (p. 278), and figured (Plate 16), in describing the arrangements for manure making on the same premises. The gelatine is used for admixture with some kinds of manure. This arrangement obviates all nuisance from the actual boiling and steaming; but the bones subsequently removed to the bone shed heat and give off offensive vapour, although apparently not so much as bones boiled in the ordinary way The bones are discharged in a friable condition, but not in so friable a condition as from Fuller's patent cylinder.

I have already described Mr. Dole's arrangement under the head of fat-melting (p. 200). The arrangements at Mr. Adams' knackery, in Birmingham, described and figured (Plate 6, p. 193) under the head of "Boiling of flesh, &c.," is well adapted to some kinds of bone boiling.

Modes of avoiding the "bone-hole" nuisance.

3rd. In some smaller bone-boiling establishments I have seen attempts made to obviate the bone-hole nuisance by carrying a pipe from the upper part of the chamber into the chimney of the establishment; but as in none of these instances has the chimney been such as to cause a sufficient draught, all such attempts have been failures.

At Harris' works, Stratford.

At Harris's establishment, at Stratford, the bone-hole is a close brick chamber from which at the roof there is a channel leading to a fan which draws air through the chamber, and sends it with the ammoniacal vapours through the boiler fire. This appears to have been fairly successful.

At Hunt's works, Bow Bridge.

At Hunt's bone works, at Bow Bridge, where in former years the spontaneous heating of explaining the method of condensation will be first to describe that in use at the most perfect works (so far as the prevention of nuisance is concerned) that I have visited, namely, those of J. Poynter at Greenock, and then to point out some modifications I have observed at other works. Plate 10 is a plan of the apparatus in use at Mr. Poynter's works. The pipes ascending from the retorts to above the level of the bank bend downwards, and dip into a wide iron pipe running horizontally about a foot above the bank, and containing water. This corresponds to the hydraulic main in ordinary gasworks, and in it the first deposition of the condensable matter of the vapours takes place. The vapours next pass by the pipes A A to a continuous condenser B similar to that used in gasworks. It consists of a series of iron pipes arranged in pairs communicating (like syphon pipes) above and opening below into receivers or boxes, into which the condensed liquids fall, and where they collect. These pipes are freely exposed to the cooling operation of the external air. From the last of these pipes the gas, still containing condensable vapours, is conducted through two coke scrubbers C C or cylinders packed with coke, through which is made to trickle down from a box E above, either water or ammoniacal liquor pumped up to it from K which is a well of such liquor below. The well K receives ammoniacal liquor from the scrubbers, and the liquor is thus made to circulate through the scrubbers until it has attained the desired strength. The gas after being thus washed passes away by the pipe D to be further dealt with elsewhere. The liquors (bone-oil, and ammoniacal liquor) condensed in the continuous condenser are first received from it in a deep narrow square vessel F, where the first rough separation of the one from the other takes place, the bone-oil coming to the top and the ammonaical liquor sinking to the bottom. Tho liquids here are prevented from rising above a certain height by an arrangement for drawing off these two products separately. The oil is allowed to flow off at the surface by an inch pipe W to a tank or barrel V sunk in the ground, while the liquor runs away by a wider pipe G which is bent like a syphon and dips into the liquor below the oil, the top of the syphon being at the same level as the pipe which carries off the oil. This pipe conveys it into a receiver H. This ammoniacal liquor still contains a large quantity of oil, and to separate the latter more completely the liquor is next pumped through the pipe I into a subsiding vessel M (in this instance a long cylindrical boiler), having taps at one end, for drawing off the oil. The oil is from time to time drawn off into the oil tank V, and the liquor is pumped out by means of the pipe X which extends to the very bottom of the tank through the pipe L into the still N. But the oil in the tank V contains ammonia which it is worth while to recover. It is, therefore, pumped from V into another tank *a* placed above the receiver H, and steam is thrown in by the perforated pipe *b* so as to wash out the ammonia. The bottom of this tank falls in the centre, where the liquor deposited from the steaming collects, and where it may be drawn up by the pipe *c* either into a barrel *d* for conveyance to the still or into the receiver H. The position of the pump by which all the pumping is performed is shown at J.

At Torr's works at Deptford the arrangements for condensation are in most respects similar. There is a continuous condenser, but both before

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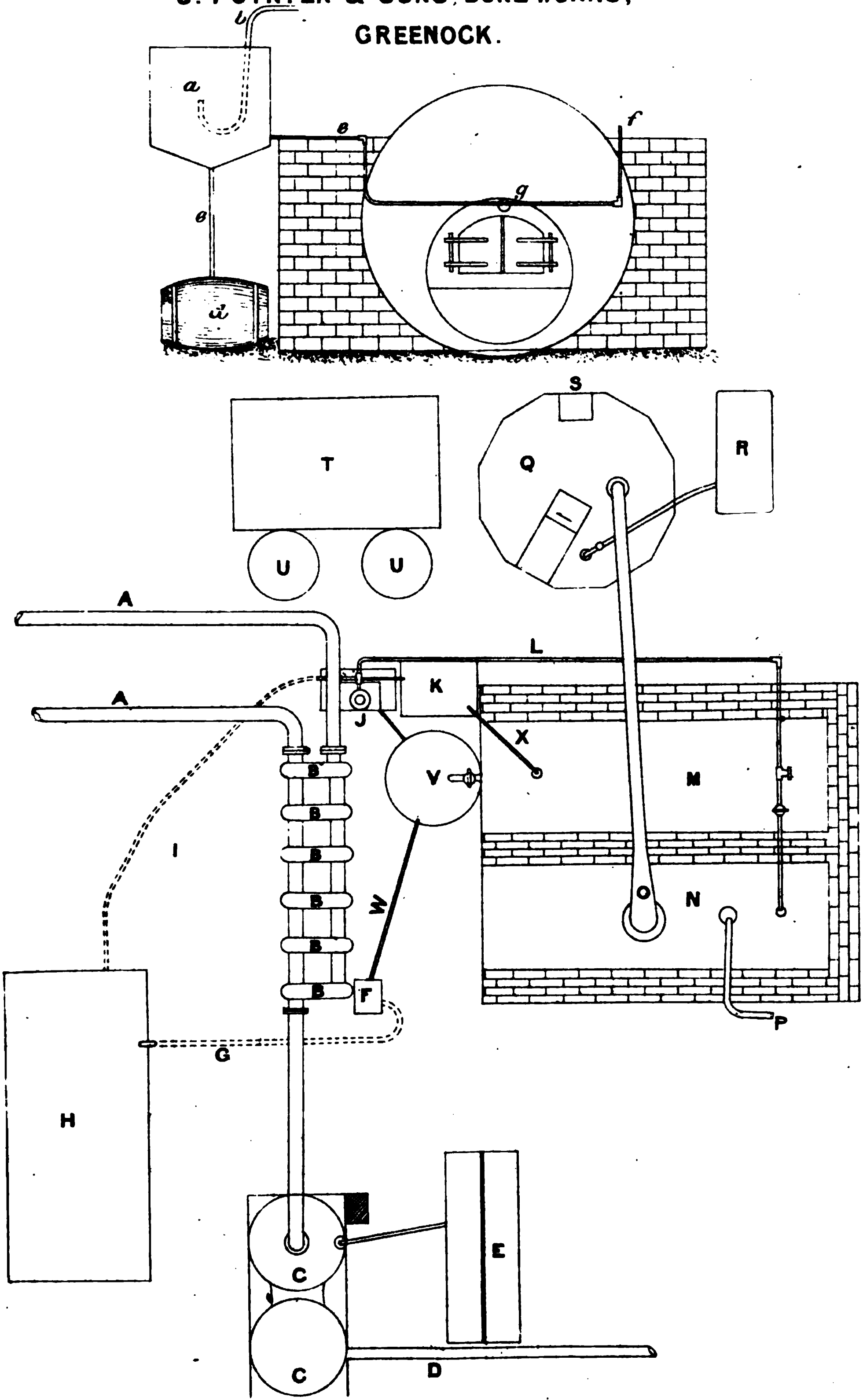
held over the mouth of a vessel containing it rapidly acquires the dark reddish-purple colour which is characteristic of the pyrrol of Runge. Acids agitated with the oil extract the bases it contains. Alkalies extract an acid oil and a considerable quantity of hydrocyanic acid.

Plate 10.

PLAN OF APPARATUS IN USE AT J. POYNTER & SON'S, BONE WORKS, GREENOCK.



Dangerfield Lith. 32. Bedford St Covent Garden

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

the vapours enter it and also after leaving it they are passed through washers or tanks containing water. There is no coke scrubber. The condensed matters from these condensers, washers, and the hydraulic main are collected in an underground tank provided with a pump, where the separation of oil and liquor takes place, and from which, by raising or depressing the pump, tar or liquor can be separately pumped up at pleasure.

At G. Lockyer's works at St. Philip's Marsh, Bristol, there is no continuous condenser, but the vapours are condensed by passing them through a series of five washers or deep closed vessels containing water. In the interior of each of these vessels is a projecting shelf beneath which the vapours are introduced, and under which they have to travel in contact with the water to escape at the upper part of the retort, round the edge of the shelf, into the space above. In these tanks the oil collects above, while the ammoniacal matters are taken up by the water below, and each is run off separately at appropriate levels.

At Lockyer's works at Temple Back, Bristol, the arrangements for condensation are similar, but here the vapours only pass through four washers, and only two of these are shelved.

I propose to describe the utilization of the oil and liquor presently.

At McFarlane's works, which are small works at Brediland near Paisley, the condensation arrangements are rough, and consist of a continuous condenser of salt-glazed ware, from which the vapours are passed into a small vessel containing water and sulphuric acid.

At D. Arthur's works near Greenock, also small works, other businesses are conjoined with that of the manufacture of bone-black, the principal of which are horse-slaughtering and manure-making. There is no hydraulic main. The oil and liquor are condensed by passing the vapour through a worm condenser, and are then run into an open pan where horseflesh is boiled for manure.

4. The gas which remains after all condensable matters have been condensed is used either for lighting purposes, as at Torr's and Poynter's works, or for burning as fuel in the boiler fires, as at Lockyer's in St. Philip's Marsh, Bristol. In other works it is allowed to escape. When used for lighting purposes it is purified from carbonic acid by passing it through an ordinary gas lime purifier in its way to the gas-holder.

5. The utilization of the char-dust and of the oil for the manufacture of an artificial manure will be described when the subject of artificial manure making is under consideration.

Manufacture of sulphate of ammonia.

The ordinary process.

The *manufacture of sulphate of ammonia* from the ammoniacal liquor is mostly effected as follows:—1. The liquor is run into an open tank lined with lead, and brown sulphuric acid is run into it in a small stream until it is saturated. During this process more or less bone oil, dissolved in the liquor, separates and forms a scum upon the surface, the liquor rises in temperature, and watery vapours smelling strongly of the oil is given off. 2. When saturated, the solution is transferred by pumping (if the tank be sunk), or by running off (if it be raised), into tanks or pans, where it is boiled down either by a fire beneath or by close steam. During this boiling large quantities of offensive steam arise, and in part condense as an oily matter upon the inside walls of the building, upon rafters, &c. The sulphate is scooped out with a perforated scoop and set aside to drain. It is of a brown colour and only fit for use in manure making.

Process at Poynter's works.

At Poynter's works at Greenock the method in use is far preferable to that which has been just described. The liquor which, under the scrubbing arrangement in use, is strongly charged with ammonia, is introduced into a still N and distilled by steam introduced by the pipe P, and the vapours are conducted through O into a lead-lined pan, or tank Q, containing water mixed with sulphuric acid, which is supplied out of an acid tank R from time to time as may be requisite to maintain constant excess of acid. As the liquor in the pan becomes supersaturated with sulphate, the salt which is then deposited at the bottom is taken out with a perforated scoop and laid aside upon the tray T to drain; the mother liquor draining from the salt runs into the tubs U and U, from which it is returned to the saturator. It is less coloured than any sulphate I have seen made in works where the ordinary process is followed. The vapours given off in the process of saturation also are less offensive at these works than at the other works I have seen, and are not allowed to escape into the building. The saturator is provided with a wooden cover having a sliding door which can be opened for purposes of manipulation, and from the space between the cover and the pan a pipe S conveys the vapours to a chimney shaft, the pull from which causes a current of air to pass in at the door and crevices of the cover and over the surface of the liquor.

Disposal of the bone oil.

The *bone oil* is variously dealt with. At some works it is put into casks and taken away by persons who purchase it; or it is burned as fuel, or mixed up with other matters in the manufacture of artificial manure upon the premises. At Poynter's works a part of the oil is used for manure making, but the greater part is pumped into an elevated tank *a*, from which a small pipe *e* conducts it, as it is wanted, to the boiler fire, into which it is blown as a spray by means of a jet of steam conducted by the pipe *f* to *g* where it issues at right angles to the opening of the pipe, at the furnace mouth. This arrangement for burning the oil and thus economising fuel apparently answers its purpose very well.

Effluvium-nuisances.

The effluvium nuisances arising from animal charcoal works depend mainly upon the escape of the vapours of bone oil and ammonia, but partly upon the associated processes, such as bone boiling and manure making. The odour of the bone oil and ammoniacal vapour is distinctive and very offensive. It will travel under favouring circumstances to long distances: the inspector of nuisances at Bristol tells me that the nuisance from the works in that neighbourhood is sometimes perceptible at a distance of one or even two miles from the works. I have myself been strongly impressed with the odour at a distance of a full half mile. Beyond the ordinary functional disturbances occasioned by the impression made upon the senses by the offensiveness of the effluvia, I have not, however, been able to discover that the effluvia have proved injurious to the health of those exposed to them.

Sources of nuisances.

Omitting further allusion here to the nuisances dependant upon the process of bone boiling, manure making, &c., all of which will be considered in their proper places, and restricting myself to those which arise from the processes of distillation and the making of sulphate of ammonia, the following may be mentioned as the ordinary sources of effluvium nuisances from such works as these:—

1. An escape or leakage of offensive vapours from the retorts and condensers may occur when the covering of the mouths of the retorts is from any cause imperfect, or when there are dilapidations of the condensing plant of a nature to permit escape. Where a large number of retorts are connected with one hydraulic main and condensing arrangement, and especially if the gas has to overcome water pressure in the course of the condensation, such leakage is more likely to occur than under the opposite circumstances, if the passage of the gas from the retorts be not assisted by the use of an exhausting engine.

2. The drawing of the charge. As soon as the retort mouth is opened, and while the charge is being drawn, a gush of partly ignited vapour arises into the retort house, and escapes from the openings at the roof into the air outside.
3. The escape of pungent ammoniacal vapours from beneath the edges of the covers of the coolers up to the time when they may be effectually luted down.
4. The escape into the external atmosphere of the gas not fully purified from its condensable constituents. This is most likely to occur in works where the gas is not collected and utilized.
5. The evolution of bone oil vapour mixed with watery vapour during the process of saturation of the ammoniacal liquor with acid, and during the process of boiling down in the manufacture of sulphate of ammonia.
6. Leakages about apparatus provided with the object of disposing of such last-named vapours.

Nothing but the exercise of great care, especially in details, will prevent such works as these being a nuisance. Nevertheless, I am satisfied that the nuisances are such as may be easily reduced to a minimum, or prevented altogether; and it is to the interest of the manufacturer thus to reduce them, since they represent a loss to him commensurate with the annoyance to his neighbours.

Modes of preventing nuisances

1. It is most important that the provision for condensation shall not be in defect of what ought to be provided for the number of retorts in use at any one time. Where, from the mode of condensation used, or from any other cause, the flow of vapour is likely to be retarded, or not to be sufficiently free, an exhausting or air pump arrangement should be added to the apparatus. Of course it is essential that the lutings shall be effectual, and that the plant shall be generally in such a condition as to avoid leakages.

2. I have seen nowhere any means in use to prevent or lessen nuisance from the escape of vapour during the drawing of the charge. Mr. John Thomson, now the manager of the Sankey sugar works at Earlestown, in Lancashire, informs me, however, that when he was connected with some works of this kind in Calcutta some years ago, he devised, and had for many years in use there, an apparatus which greatly expedited the process of emptying the retorts; and in this way he was enabled to reduce the amount of vapour given off. This consisted of a plate of iron one quarter of an inch thick, shaped so as to slip easily into the retort, and fitted with a long iron handle. The lower edge of the iron disc was made to fit the bottom of the retort, so that in pulling it out it would scrape everything before it, but in other parts of its circumference it was not made to fit the retort accurately. The handle consisted of a strong iron rod, made especially strong at the further end where it was turned up and riveted along the whole diameter of the face of the disc. It was sufficiently long to reach from the disc. when pushed up to the end of the retort, to the back of the retort door. Here it was provided with an eye. The rod or handle was thus made to lie within and along the whole length of the bottom of the retort. Before charging the retort, the disc was pushed in until it was brought quite to the further end; the retort was then charged, shut up, and fired in the usual way. The charge was drawn thus: immediately the door of the retort was opened, the workman passed a hook at the end of a long handle through the eye of the rod, and, with the assistance of another workman, drew forward the disc which scraped out before it the whole contents of the retort into the iron box provided to receive them. This was the work of only a few seconds; the retort door was instantly replaced, and a little soft clay was swept round the margin as luting.

App. No. 6.

On Effluvium-Nuisances, by Dr. Ballard.

3. There should be no delay, as soon as a cooler is filled, in luting down the cover. The ordinary practice is to put on the cover at once, and then to wheel the cooler to the outside of the retort house before the cover is luted down; and I have seen a row of such coolers left to stand outside for some time until it was convenient to the workmen to lute them all down consecutively. I see no good reason why the luting should not be done in the retort house immediately the cover is fixed in its place.

4. The gas should never be allowed to escape into the atmosphere. It should be collected in a gas holder, and utilized in some way.

5. Owing to the ready condensability both of watery ammoniacal vapour and bone oil vapour, and the combustability of the latter, there can be no difficulty in preventing the nuisance that arises in the ordinary process of saturation and boiling down. The tanks or pans might be covered with an iron hood or cover capable of being partially raised or opened when requisite, from which a pipe might lead to a worm condenser or other cooling apparatus, terminating in a close box or receiver, from which another pipe should lead to a furnace fire, where the uncondensed vapours may be consumed. But the first essential of nuisance prevention is the previous thorough separation of the oil from the liquor in the earlier stages of the work. The more free the liquor be from admixture with oil, the less will be the nuisance, whatever method of making sulphate may be adopted; and too much pains cannot be bestowed in effecting the separation perfectly. To the fact of such pains being taken at Poynter's works must be attributed, I think, much of his success in preventing nuisance from this part of his work. But in other respects his process is far preferable to the ordinary one, although it might be improved, as it appears to me, by the substitution for his saturation pan of the curtained saturator, now largely used in works where gas liquor is used as the source of the ammonia, and by condensing the vapours that issue, conducting such as are not condensable through a fire, where they would be burned up.

6. It is scarcely necessary to say that leakage from dilapidations of the plant, and in the flues and conduits for vapours ought not to be permitted.

The Re-burning of Animal Charcoal. Establishments visited.

THE RE-BURNING (REVIVIFICATION) OF ANIMAL CHARCOAL.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 3, 1875	J. F. Brinjes - -	Whitechapel.	
Dec. 18 „	British and Irish Sugar Works.	Plymouth -	Sugar refining.
Jan. 12, 1876	Hills, Garton, & Co. -	Southampton -	Manufacture of "Saccharum."
„ 26 „	Wolff - - -	Bristol -	Sugar-refining.
„ „ „	Old Market Sugar-house.	Do. -	Do.
„ 27 „	Finzel - - -	Do. -	Do.
Feb. 17 „	The Sankey Sugar Co.	Earlstown, Lancashire.	Do.
Mar. 26, 1877	Blair & Co. - -	Greenock -	Do.
„ „ „	Alex. Scott & Sons -	Do. -	Do.
April 17 „	James Duncan -	Victoria Docks	Do.
May 14 „	Macfie & Sons -	Liverpool -	Do.

Animal charcoal used in sugar refining.

The most important of the uses to which bone charcoal is applied in the manufacturing arts is its use for the decolourisation of syrup in sugar refineries. At these establishments a filtered solution of raw sugar is passed through large vats or cylinders (kept warm by appropriate means) containing bone charcoal in the crushed state described in the last section. In passing through the charcoal the syrup parts with colouring matters and some other matters also, such as gummy and albuminous substances, saline matters, especially calcic salts, and probably also some acid matters, organic and inorganic, as well as some of the sugar itself, which matters are retained by the char. Of these matters the char can only take up a limited quantity, so that while the earlier portions of syrup run through pass out absolutely colourless, the subsequent portions pass out more or less coloured, the colouration increasing gradually until the time arrives when the manufacturer finds that the charcoal has ceased to purify the syrup sufficiently for any of his purposes. This time usually arrives after about two days continued use, at some works even within a much shorter time. But it has been found that the purifying properties of the char may be restored by reburning it. It is this process of reburning or revivification which I am now about to describe.

Process. Preliminary washing.

Before the char is reburned it is necessary to wash it thoroughly to recover from it as much as possible of the sugar it has retained. With this object hot water is run through it, as it lies in the charcoal cistern, this washing being continued so long as sugar is recoverable in sufficient quantity to be of value to the manufacturer. The sweet water thus obtained contains not only sugar but also some of the organic and saline impurities which had been removed from the syrup. The water is drained away, and the char is then ready to be taken out and reburned. After draining, however, it still contains about 20 to 25 per cent. of water, and is quite damp to the hand.

The practice of washing the char, after its removal from the cylinders, with hydrochloric acid, with the object of taking out lime, appears, so far as I have been able to learn, to be rarely adopted in this country. But when the washing with hot water is performed too slowly the weak saccharine solution which results is apt to acetify, and this produces a similar result, which is recognised by the solution being opaque when it is run off. I am informed that this acetification is more likely to occur when the char has been in use for too long a time, and in old more readily than in new char. New char will often give off liquors smelling of sulphuretted hydrogen when the sugar refined is acid. Acetification will also occur under conditions of a sugar refinery which are little understood, but over which the managers are said to have no power of control. Also when imperfectly washed char, which after draining may still retain sweet water, is allowed to stand for some indefinite time before being reburned (not being reburned quickly after washing), it is apt to ferment and acetify. This fermentation is regarded as a benefit to the char, serving to open the char by removing matters within its pores which mere washing will not remove. It is mentioned in works upon the subject as one of the processes of revivification, and is said to be practised in some British factories. Sometimes the char is sent away from the premises to be reburned elsewhere; but in nearly all instances it is reburned upon the refining premises, a part of which is devoted to this process.

At all the works that I have visited I have found in use one of the two kinds of reburning apparatus that I am about to describe, or some

Reburners.

modification of them; the modifications, however, not being, for the most part, of a character to affect the subject matter of this report.

1. Ordinary pipe kiln.

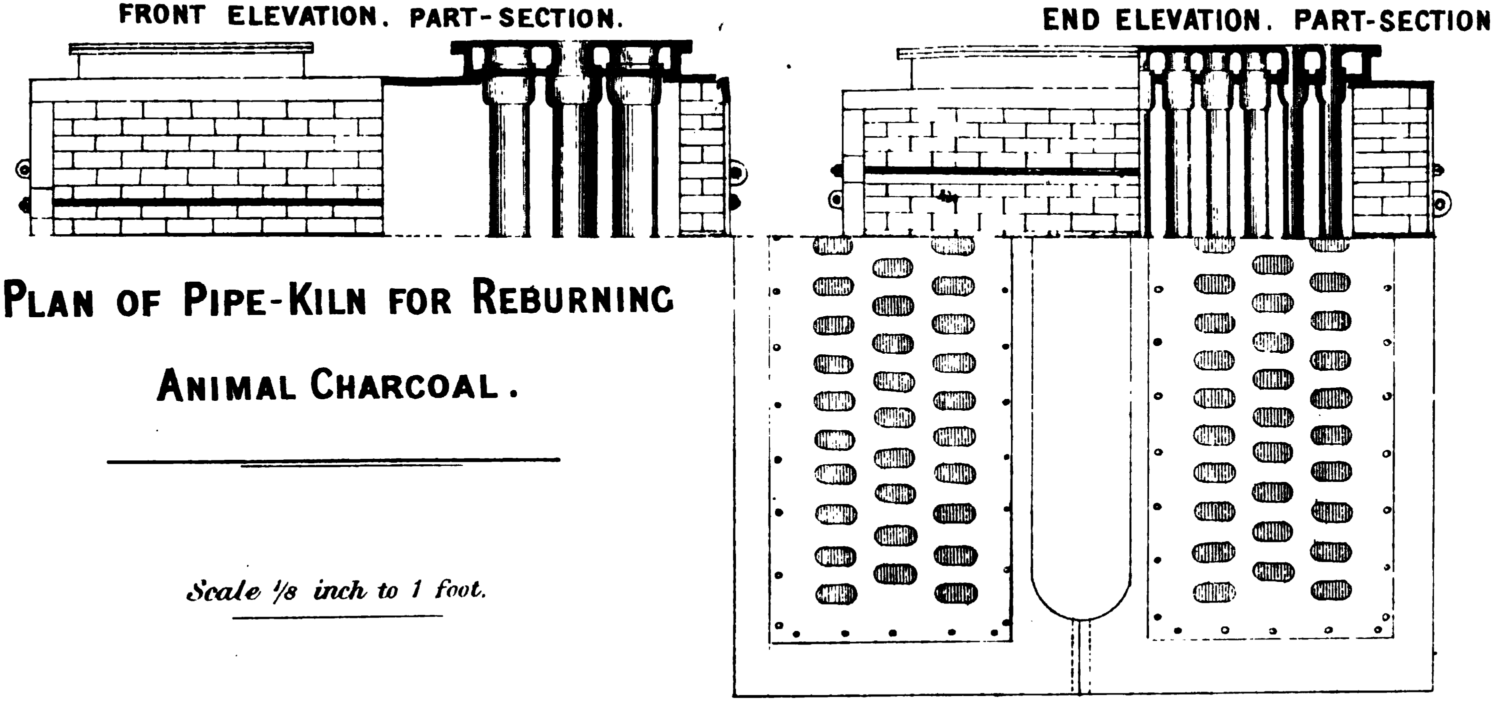
1. The pipe or tubular kiln or reburner. Messrs. McLean and Angus, engineers of Greenock, have been good enough to furnish me with a drawing of the ordinary form of this apparatus (Plate 11) which will assist me in describing it. Each reburner consists of a series of 64 iron pipes of the shape shown in the drawing, arranged in two banks or groups of 32 each on either side of a central fire, the whole being raised upon iron columns which being hollow are made to serve as flues. The flame from the fire plays among these pipes, and its direction, &c. are regulated by appropriate dampers. In the brickwork enclosing the pipes there is opposite each group an iron plate A., with an arrangement for viewing the state of ignition of the several rows of pipes. Beneath each of the six rows into which the pipes are distributed is a narrow iron box freely exposed to the air, and serving as a cooler for the reburned char. A slide valve at B. permits the discharge into the cooler of the lower portion of the contents of the pipes from time to time, the coolers being emptied below upon the floor, or into appropriate vessels run in below them. The top of the kiln where the open ends of the pipes appear as shown in the drawing, forms a stage or platform near the roof of the building or shed where the apparatus stands. Upon this platform the damp char is placed and heaped up, and there it undergoes some preliminary drying by evaporation. Whenever a cooler is refilled the char sinks commensurately in the pipes corresponding to it, and a workman upon the platform at once with a shovel refills the pipes to the top. Whatever vapours are evolved from the reburning escape from the top of the char pipes and pass out of the building through openings in the roof.

Buchanan's reburner.

Buchanan's reburner is a modification of the tubular reburner which, while it is said to burn the char more equably, provides for the collection of the vapours that are given off. Plate 12 shows those parts of the apparatus which it is necessary here to describe. The tubes A are arranged much in the same way as in the ordinary reburner. Each pipe, however, is double, consisting of a wide external tube *a*, and a narrower internal tube *b*, and the char, falling from a stage or platform *g* above, occupies the space *c* between the two tubes. The internal tube is provided with openings *d* in its circumference at definite intervals, and these openings are protected from the ingress of char by a louvre-like projecting plate, inclined downwards at an angle, from the part of the tube immediately above them. The vapours given off during the reburning pass through these openings into the interior of the tube *b* which above opens, together with other tubes in the same row, into a horizontal channel or flue *e* which conducts the vapours away. The outer tube is made to revolve in its longitudinal axis around the inner one. There is also a modification of the cooler *f* below, which need not be here described.

2. Revolving cylinders. Brinjes' reburner.

2. Revolving cylinders, of which perhaps the best is Brinjes' patent reburner. Mr. Brinjes has kindly furnished me with a drawing of this apparatus (Plate 13) and with the following description of it. "Fig. 1 " represents a front elevation of the apparatus complete; fig. 2 is a " sectional elevation of the same; fig. 3 is a back elevation, and fig. 4 " a sectional plan thereof. A is the brick setting of the horizontal " retorts, B and C, each of which receives a circular reciprocating " or alternating motion of nearly one entire revolution on its longi- " tudinal axis. The upper retort acts as a drying chamber for preparing



PLAN OF PIPE-KILN FOR REBURNING ANIMAL CHARCOAL.

Scale ⅛ inch to 1 foot.

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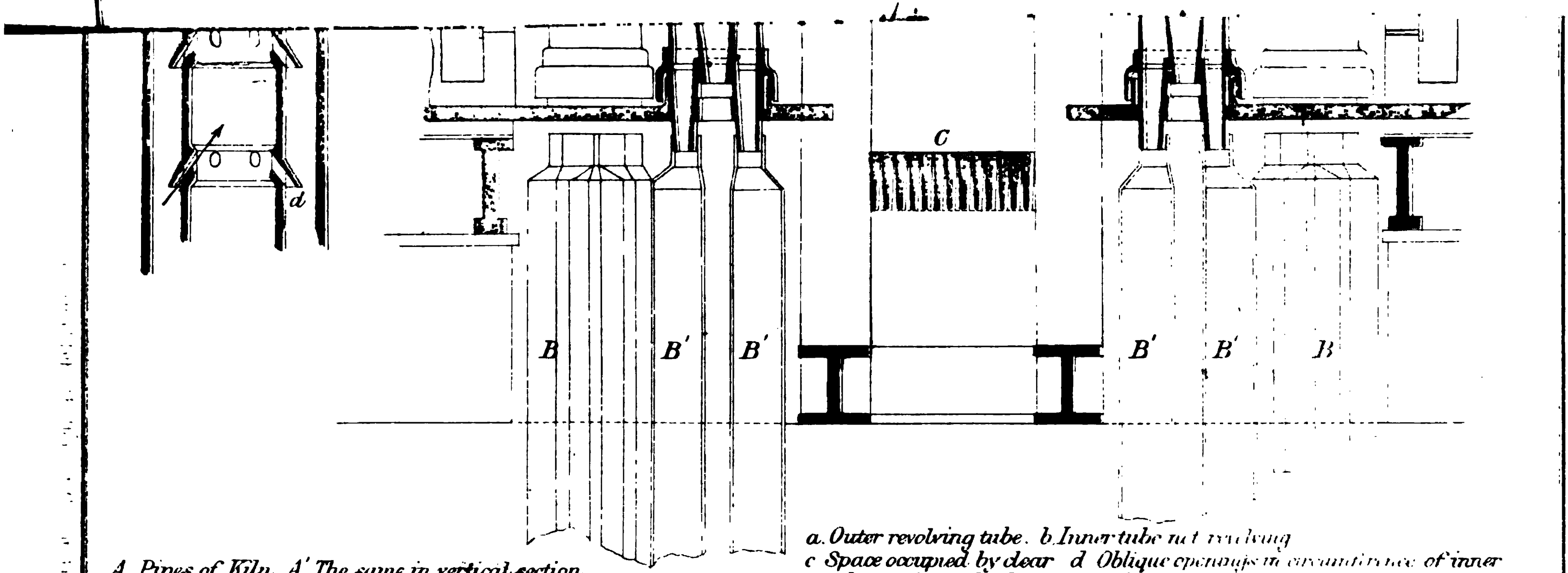
TILDEN FOUNDATIONS

BUCHANAN & VICKESS' PATENT KILNS.



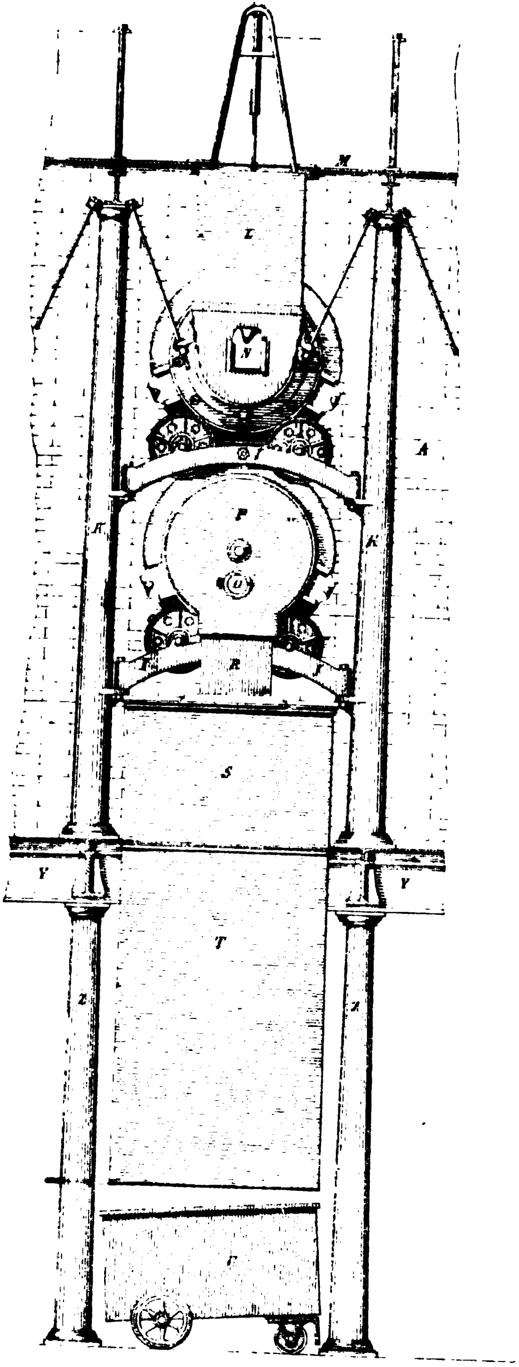
A. Pipes of Kiln. A′ The same in vertical section.
B. Coolers which revolve. B′ The same in vertical section.
C Fire-place

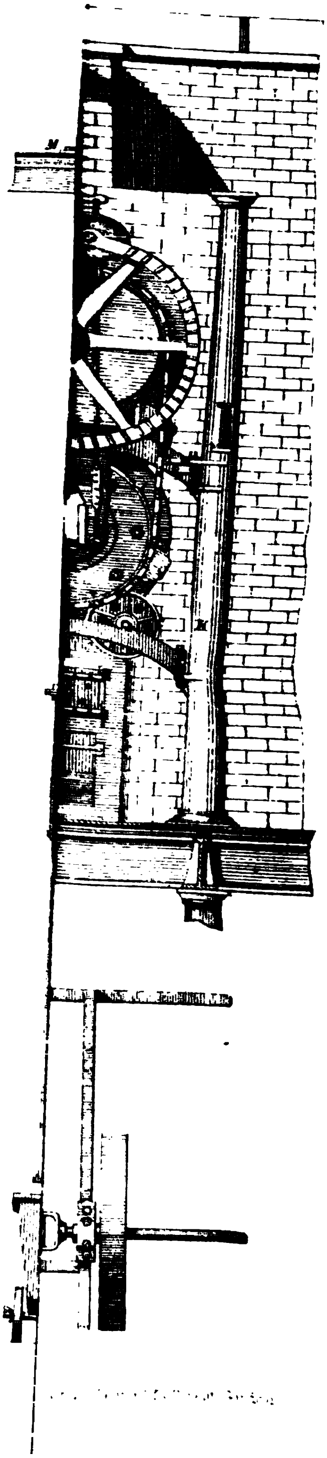
a. Outer revolving tube. b. Inner tube not revolving
c Space occupied by clear d Oblique openings in circumference of inner tube. e. Flue with which inner tube communicates
course of vapour indicated by the arrows ⟶

A

B.

Fig. 1.





“ the charcoal for the recarbonization which takes places in the lower retort; and it is contained in a separate brick chamber of its own, which is situated immediately above the roof of the furnace or fire place D, the heat from which, after circulating round the lower retort, enters the upper chamber through openings left for that purpose in the roof of the furnace, and then acts upon the upper retort before passing off to the chimney. E E are passages provided with dampers and leading to the main flue F below. The two retorts are provided with a series of internal flanges, *a a*, at intervals of about 6 or 8 inches, and ledges are formed between the flanges for carrying up the charcoal as the retorts reciprocate. An opening is made through each flange and all these openings are disposed in a line with each other. In order to cause the charcoal to travel continuously along the retorts during the process of recarbonizing, an angled projection, somewhat after the form of a three-sided pyramid, *b*, is cast inside the cylinder in each of the intervals or spaces between the several internal rings or flanges, and exactly in the centre line of the openings in those flanges. The two opposite sides of these projections present reverse angles, both of which direct the charcoal into the next interval or space on the partial rotation of the retort; the upper retort is driven direct by a mangle-wheel and pinion arrangement, G, or other mechanical equivalent; and this motion is transmitted to the lower retort by means of the endless chain, H, suspended from the rear end of the upper retort and passing under the corresponding end of the lower retort. Both ends of the retorts are supported upon anti-friction pulleys *c c*, carried in the transverse aming I, bolted to the main supporting column K K. The feeding pper L opens to a flue M, from which the charcoal is shovelled hen being supplied to the retorts, the feed being nicely adjusted by eans of the sliding door *d*, worked by a winch handle and screw indle. N is a sliding door, covering an opening in the inclined le of the hopper for the purpose of inspecting the interior of the tort; a spy-hole being also provided at O in the stationary front ver P, of the lower retort, for the same purpose. The upper tort discharges its contents into the conduit Q, which conducts it the lower retort, after traversing which it is discharged down the e R into the closed box or receiver S. From this receiver it passes rough the cooler, which consists of a number of long narrow ssages, T, placed side by side, and having intervening air spaces tween them for the more effectual cooling of the same. By the me the charcoal has traversed these coolers it is sufficiently cool to e exposed to the action of the atmosphere and is discharged into a all truck or waggon, U. The vapours which are evolved during e reburning of the charcoal are carried off by the pipe V, provided ith a throttle valve W, into the chamber X, communicating with e chimney. The entire arrangement is supported upon strong iron rders Y, resting upon column Z, in the basement.”

hen the reburned char is cold it is sifted, the dust is sent away to nanure makers, or used by the refiner in his “blow-up” pans where sugar is dissolved, while the sifted char is returned, with so much r as is requisite to make up for loss by sifting, to the charcoal

Effluvium-nuisances.

the most favourable circumstances the vapour that issues from rocess of reburning has an odour, usually sweetish and slightly matic. I have never observed the odour to be of a character erved the term “overpowering” being applied to it, but it is sometimes sufficiently pronounced to be very disagreeable. In the "Times" newspaper of June 15, 1857, I find an account of a trial in the Court of Queen's Bench, upon indictment of Fairrie and others for a nuisance arising out of the reburning of animal charcoal at an establishment in Whitechapel. The indictment was successfully sustained after a trial that lasted three days. At these works it would appear from the evidence, as published, that the pipe-kiln was in use, and several witnesses from the neighbourhood deposed that they were greatly annoyed by the offensive vapours, some of them designating the odour as "disgusting," and stating that their health was injured by them, headache, sickness, vomiting, and difficulty of breathing being the symptoms specially mentioned. The late Dr. R. D. Thomson, a distinguished chemist, and at that time one of the Medical Officers of Health in the metropolis, stated that he had found by experiment that the gases and vapours given off consisted of carbonic oxide, carbonic acid, various hydrocarbons, and sulphide of ammonium, acetate of ammonia, and carbonate of ammonia, and Mr. Redwood, the Professor of Chemistry at the Pharmaceutical Society, confirmed him in all these respects.

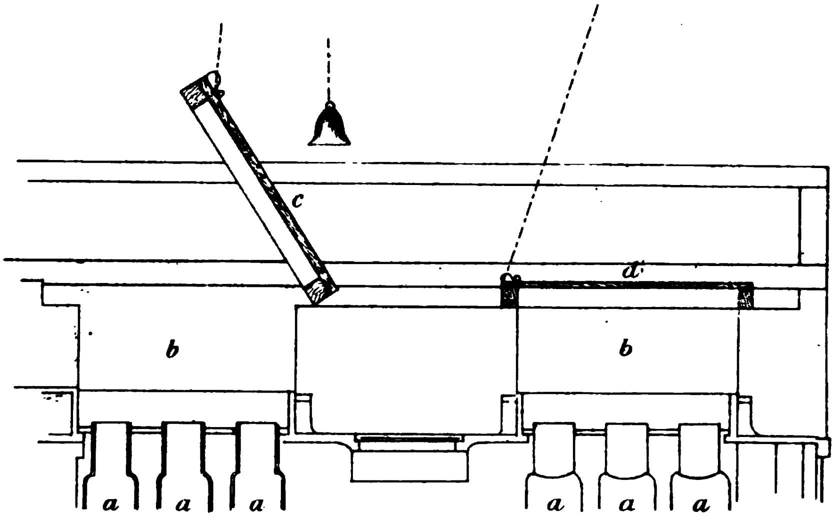
Sources of nuisance.

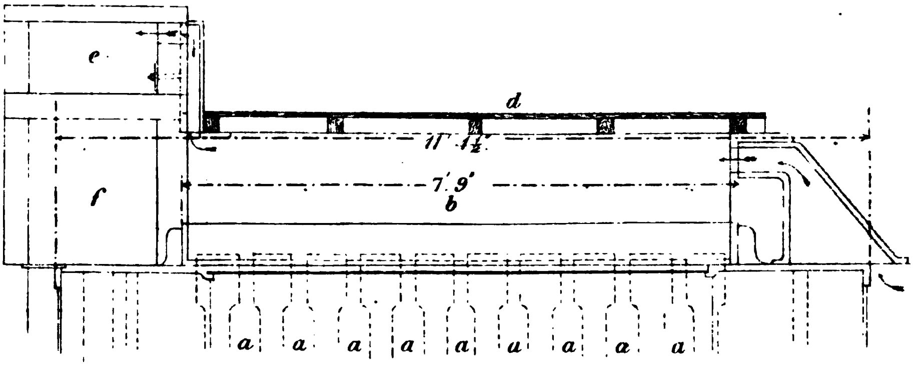
At the time of this occurrence (or up to about 15 or 20 years ago), blood (just as it came from the slaughter house) was, I am informed, universally used by sugar refiners in their blow-up pans, a pailful being usually added to the contents of each pan. Now, however, it is said to be rarely used, or, if any form of albumen is used, it is one of the inferior dark coloured kinds of blood albumen the preparation of which has been described at p. 214. When the solution of raw sugar after this admixture was filtered, the fibrin of the blood and the greater part of the albumen would of course remain within the filtered bags, forming thus one element of the "sugar scum;" but some might, and probably would, pass through, and certainly the filtered solution would contain the non-coagulable animal principles of the serosity ; and these would be retained in the char when the syrup was filtered through it, giving rise to very offensive vapours on the char being reburned. The same thing must happen even now when blood or blood albumen are used. When the used char is permitted to ferment, the acetic acid formed acts upon the sulphides of calcium and iron present, eliminating sulphuretted hydrogen, the odour of which is perceptible, and which is given off when the char is reburned. Indeed it has, I am told, now and then happened that the quantity of sulphuretted hydrogen given off has been sufficient to cause an explosion on a lighted candle being accidentally brought near the top of the cistern, when the door at the top of it has been opened. New char also contains sulphide of ammonium, and this is given off during reburning.

Modes of preventing nuisance.

That the nuisance from reburning is capable of being reduced by due care to a minimum is shown by the fact that, even in the case of Fairrie just alluded to, it was so reduced a few days before the trial commenced. Dr. Odling gave evidence to the effect that on June 2 he made experiments at the works, that at that time there was only a slight smell issuing from the tubes, and that the vapour given off did not contain either sulphide of ammonium or carbonate of ammonia; and the late Mr. Brande, of the Royal Institution, who experimented at the works on June 5, gave similar evidence. And I myself, unexpectedly visiting works where tube kilns have been in full operation, have often found very little offensiveness in the issuing vapours, certainly no more than might well, when diluted by the external air, be tolerated by the residents of any neighbourhood, however sensitive. Even at Macfie's Batchelor Street Works in Liverpool, at which blood is used, the vapours

PLAN OF THE ARRANGEMENT FOR COLLECTING VAPOURS EMANATING FROM PIPE KILNS AT DUNCAN'S SUGAR REFINERY, VICTORIA DOCKS.





a. Upper part of pipes of kiln.
b. Flue into which they open above and which contains char about to be re-burned.
c. Wooden cover of flue raised by a pulley when the pipes are to be filled up.
d. Cover in its place covering in the top of the flue.
e. Flue for receiving vapours from b.
f. Flue for smoke from the kiln.
arrows show the course of the vapours.

Hangerfield 22 Bedford St Covent Garden

proceeding from the ordinary pipe-kilns were not at the time of my visit exceptionally disagreeable or productive of nuisance; but at these works very great care is taken in the thorough washing of the char. I have never perceived any ill odours proceeding from works where Brinjes' patent reburner was alone in use.

Whatever ill odours may attach to the vapours must depend upon the evolution of sulphuretted hydrogen and sulphides, and the products of decomposition of the organic matters, hydrocarbonaceous and nitrogenous, taken out of the raw sugar in its passage through the charcoal purifiers. The remedies for the nuisance, then, are obvious, and they consist:

1. In the thorough washing of the char before reburning, so as to remove from it as much as it is possible to remove of those matters, which by their burning gives rise to offensive effluvia. At Duncan's works mechanical means are in use to hasten the passage of the syrup through the char, and the washings, similarly hastened, are continued for six or seven hours after the last of the sweet water has been removed. The time that elapses from charging a charcoal cistern to the char again going to the reburner is not more than 35 hours. Fermentation is thus, as I am informed, altogether prevented.

2. Means should be adopted for collecting and disposing inoffensively of the vapours proceeding from the reburning. When Brinjes' reburner is in use, the vapours are collected as a matter of course, and at the Whitechapel works alluded to above (which have since the date of the trial passed into the hands of Mr. Brinjes), the old pipe kilns have been replaced by his cylinders, and no nuisance whatever is occasioned. At these works the vapours are conducted first into a long brick chamber or flue 3 feet square internally, and thence into a chimney shaft at a point below that at which the furnace flue enters; this shaft discharges them at a sufficient elevation to prevent any nuisance, and at other works that I have visited, I have seen the vapours discharged at once into a tall chimney shaft without occasioning nuisance. Should it be thought necessary, a means of condensation might readily be added to this apparatus. There may be some difficulty in collecting the vapours proceeding from pipe kilns, but it is nevertheless practicable. Dr. Odling stated at Fairrie's trial that the collection had been effected by drawing off the vapours accumulating beneath the roof above the kilns by means of a fan which drove them into the chimney shaft. At Duncan's sugar works a space above each stack of pipe kilns is boxed in with a wooden cover: hot air is conducted into this space from the fire by means of an appropriate flue at one end and passes out at the other end, carrying the vapours with it into a chimney. This arrangement is shown in Plate 14. At one part of these works there is a common horizontal flue to receive all the vapours from a row of reburners, and should it be requisite the vapours might very readily be condensed; after condensation of all that is condensable the remainder might be passed through a fire. One of the advantages of Buchanan's reburner is that provision is made for the collection of the vapours.

I lay some stress upon an arrangement having this object in view being generally adopted, because notwithstanding all the care a manager may take, he is still to a considerable degree in the hands of his workmen.

The Manufacture of Artificial Manures.
Establishments visited.

The Manufacture of Artificial Manures.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
1873 During a special inquiry on the banks of the Thames.	Jas. Gibbs & Co. -	Victoria Docks, West Ham.	Manufacture of sulphuric acid.
„	Odam - -	Do. - -	Do.
„	Thos. Farmer & Co.	Do. - -	Do.
„	Shroeder & Co. -	Do. - -	(Dissolve guano), manufacture of sulphuric acid.
„	Mockford & Co. -	East Greenwich.	
„	Lawes & Co. -	Barking Creek -	Manufacture of sulphuric acid.
„	F. C. Hills -	East Greenwich -	Manufacture of sulphuric acid, sulphate of ammonia, &c.
„	Bevington -	Erith Marshes -	(Scutch manure), extraction of fat from scutch.
„	Brown - -	Do. - -	(Scutch manure), extraction of fat from scutch, glue making.
„	Miller & Johnson -	Rainham Ferry, Essex.	Manufacture of sulphuric acid.
„	Wilson - -	Do. - -	Do.
„	Borell & Hagan -	Do. - -	(Scutch manure).
1874 - -	Bradburn -	Wednesfield -	Sulphuric acid.
	H. J. Salmon -	Britannia Works, Bermondsey.	Dealer in spent hops, rape cake, shoddy, woollen rags, and wool waste.
Nov. 9, 1875	Arnott Bros. & Co.	Millwall.	
„ „ „	Gould & Co. -	Do. - -	Manufacture of sulphuric acid.
„ „ „	Purser & Co. -	Do. - -	Do.
„ 22 „	Newton - -	South Bermondsey	
„ 29 „	Town Manure Co.	Bilston - -	(Poudrette from night soil).
Dec. 17 „	Burnard, Lack, & Alger.	Plymouth -	Manufacture of sulphuric acid.
„ 16 „	Norrington -	Do. - -	Do.
„ 17 „	Jas. Gibbs & Co. -	Do.	
„ 22 „	Western Counties Manure Works.	Tor Point, opposite Devonport.	Manufacture of sulphuric acid.
Jan. 1, 1876	Ball & Davis -	Hunslet, Leeds -	Glue making.
„ 5 „	G. Hallett & Co. -	Rotherhithe -	Refining of antimony.
„ „ „	Hale - -	South Bermondsey	Blood boiling, dealer in scutch and shoddy.
Jan. 5, 1876	Two small works.	Under railway arches Rotherhithe.	(Manure made from blood, fish, sawdust, &c.)
„ 6 „	Mockford & Co. -	Ordnance Works, East Greenwich.	(*Second visit.*)
„ „ „	F. C. Hills -	East Greenwich -	(*Second visit.*)
„ 11 „	Dixon & Cardus -	Northam, Southampton.	Bone boiling, oil boiling.
„ 12 „	A. W. Hall & Co.	Redbridge, Southampton.	Manufacture of sulphuric acid.
„ „ „	Gabriel Scott -	Nursling, Southampton.	Bone boiling.
„ „ „	Spooner & Bailey	Eling, Southampton.	Manufacture of sulphuric acid.
„ 20 „	Netham Chemical Works.	Bristol - -	Manufacture of sulphuric acid and of alkali and bleaching powder.
„ „ „	Norrington, Hingstone, & Co.	Do.	

Establishments visited—*cont.*

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Jan. 21, 1876	H. & T. Proctor -	Bristol - -	Bone boiling.
„ „ „	Cottrell - - -	Do. - -	(Scutch manure), fat melting, &c.
„ „ „	Kent - -	Do.	
„ „ „	Prangley & Co. -	Do. - -	Knackery, boiling of flesh.
„ „ „	Bryant & Co. - -	Do.	
„ „ „	Robinson - -	Do.	
„ „ „	Turner - -	Do. - -	(Scutch manure). Extraction of fat from Scutch.
Feb. 23 „	Bell - -	Stratford, Essex -	Manufacture of sulphuric acid.
„ „ „	Hales - -	Do.	
„ „ „	F. Hempleman -	West Ham -	Blood boiling and drying.
„ „ „	Newton, Keate, & Co.	Sutton, near St. Helens, Lancashire.	Manufacture of sulphuric acid, phosphoric acid, &c.
„ 24 „	Hunt - -	Bow Bridge -	Bone boiling.
Mar. 20 „	Morris & Griffin -	Wolverhampton -	Bone steaming, manufacture of sulphuric acid.
„ 21 „	Town Manure Works.	Bilston - -	(*Second visit.*)
April 1 „	Towns - -	Melton Mowbray -	Knackery.
May 13 „	E. Packard & Co.	Bramford, Suffolk -	Manufacture of sulphuric acid and sulphate of ammonia.
„ „ „	J. Fison - -	Do. -	Manufacture of sulphuric acid.
„ 16 „	Thos. Vickers & Sons.	Manchester -	Bone boiling, size making, soap making.
„ 17 „	Walshe - -	Manchester Abattoir.	Blood albumen making.
„ 19 „	Thos. Vickers & Sons.	Widnes - -	Manufacture of sulphuric acid.
June 1 „	Phillips - -	Leeds - -	Bone steaming.
Nov. 16 „	E. Cook - -	Bow Bridge -	Bone boiling, fat melting, soap making, &c.
„ 17 „	Bevington -	Erith Marshes -	(*Second visit.*)
„ 22 „	Jas. Gibbs & Co. -	Victoria Docks -	(*Second visit.*)
„ 23 „	Odam - -	Do. - -	(*Second visit*).
„ „ „	Ohlendorf	Do. - -	(*Second visit.* Formerly Shroeder).
Nov. 28 „	Hereford Manure Company.	Hereford - -	Manufacture of sulphuric acid.
Dec. 4 „	J. Thomson & Sons	Glasgow.	
„ 8 „	Hart - -	Hull & Wilmington.	
„ „ „	Hunter - -	Wilmington.	
„ „ „	Officer - -	Hull - -	Glue making.
„ „ „	Foster - -	Little Driffield -	Fellmongering, leather dressing and tanning.
„ „ „	Nicholson -	Do. - -	Fellmongering, flesh and bone boiling.
Jan. 31, 1877	James Coles -	Near Calne.	
Feb. 1 „	Spence - -	Dumball, Bridgwater.	Manufacture of sulphuric acid.
„ 2 „	Norrington -	Plymouth - -	(*Second visit.*)
„ „ „	Burnard, Lack, & Alger.	Do. - -	(*Second visit.*)
„ 3 „	Jas. Gibbs & Co. -	Do. - -	(*Second visit.*)
„ 13 „	Proctor & Ryland	Birmingham -	Bone boiling.
„ 14 „	Gen. Scott's Works	Saltley.	
Mar. 15 „	Walton - -	Near Cambridge -	Knackery, flesh boiling, pig keeping.

ESTABLISHMENTS VISITED—*cont.*

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Mar. 26, 1877	Langdale - -	Newcastle-on-Tyne	Manufacture of sulphuric acid.
" " "	Burrell - -	Do.	
" 27 "	Arthur - -	Greenock -	Manufacture of animal charcoal, knackery.
Mar. 28 "	J. Poynter & Sons	Do. - -	Manufacture of animal charcoal, and of sulphuric acid, sulphate of ammonia, &c.
" " "	G. J. MacFarlane -	Brediland, Paisley	Manufacture of animal charcoal and of sulphate of ammonia.

Importance of the trade.

This manufacture ranks among chemical trades second only to alkali making in importance, in size of the establishments, and in respect of the number of persons and capital embarked in it. It is, therefore, not without some sense of diffidence that I approach the subject, which I should scarcely have been in a position to treat of at all, had it not been for the cordial assistance I have received from the manufacturers themselves, and the large amount of information respecting their trade and its details that they have been good enough to give me. To some of them I am under very great obligations in this respect, and I may especially mention Mr. Burnard, of the firm of Burnard, Lack, and Alger, of Plymouth; Messrs. Gibbs, of Victoria Docks; and Mr. William Vickers, of Manchester and Widnes. The last-named gentleman has very kindly assisted me by reading through the proof sheets of this section, and freeing the report, as I hope will be found to be the case, from technical errors. One difficulty I felt (and it is an initial difficulty) was in deciding what was to be regarded as an artificial manure in the sense of this section, and whether I ought to include what are ordinarily termed "composts," that is to say, mixtures of excrement, human or otherwise, with other ordinary refuse matters, such as ashes or litter. In deciding this question I have arrived at a compromise, and have simply consulted the convenience of the inquiry by deferring to a later section the consideration of the manufacture of those manures which are made by mixing human excrement, simply or principally, with the materials furnished during the collection of town refuse by local sanitary authorities or their contractors. On the other hand, I have found it convenient to include in this section some of the processes by which human excrement is utilised for the manufacture of manure.

Materials used.

The list of materials used in the manufacture of artificial manures is a long one. They may in general terms be described as phosphatic materials, nitrogenous or ammonia producing materials, saline materials, and dryers or deodorants.

Phosphatic.

The phosphatic materials used are coprolites, apatite, phosphorites, South Carolina, French, and other mineral phosphates, some having a bone origin and containing fossil bones, Mejillones, Sombrero and other phosphatic guanos, and bones boiled and then crushed, bone char, and bone char-dust from sugar refineries and manufactories of animal charcoal, calcined bones, sugar scum (the pressed residues of filtration of solution of raw sugar), &c. These materials also supply other useful elements to the manure. Sugar scum may not only contain the solid impurities of raw sugar, but, when blood is used in refining sugar, it also contains the coagulable constituents of this substance: it also contains bone-char when the char dust is utilised by mixing it with the solution of sugar in the "blow-up" pan. The scum of Hills, Garton, & Co., of Southampton, is said to contain from 18 to 20 per cent. of phosphate of lime. The nitrogenous materials in use are such as these, viz.: ammoniacal guano, blood (either in the form of wet or dried clot), sometimes flesh (horseflesh or diseased or putrid meat, boiled or unboiled), and offal from slaughter-houses, leather, bits of skin and wool from trotter boilers, &c., shoddy, scutch (the refuse from glue works), occasionally night-soil, &c. The saline materials are common salt, nitrate of soda, sulphate of ammonia, &c. The dryers and deodorants are such substances as gypsum, soot and flue dust, the ashes of burnt tan, &c. The materials of the manure are selected from among these according to the nature of the manure required, the peculiarities of the trade of the manufacturer, their abundance or the facility with which they are obtained and their relative prices. In making them into manure sulphuric acid or occasionally hydrochloric acid is used.

Nitrogenous.

Saline, &c.

The following analyses of some of the materials used (as I am informed) in this country, may be usefully quoted in relation to the subject of this report, especially as showing the variations in the proportions of lime and fluoride in the phosphates. They are taken from Voelcker's paper in the journal of the Royal Agricultural Society (1875), from Dr. Morfit's work on mineral phosphates, and from other sources, published and unpublished:—

Various analyses of phosphates, &c.

ANALYTICAL TABLE of the COMPARATIVE COMPOSITION of some NATURAL, CRUDE PHOSPHATES of LIME.

(*From Morfit's Work.*)

Components.	Apatite from Norway. (*Voelcker.*)	Phosphorite from Spain. (*Ogston.*)	Phosphorite from Germany. (*Fresenius.*)	Bone ash from South America. (*Morfit.*)	Bone black from sugar refineries. (*Morfit.*)	True Coprolites, Cambridge. (*Way.*)	False Coprolites, Suffolk. (*Herepath.*)	Marlstones or South Carolina Phosphate (*Morfit.*)
Bone or tri-phosphate of lime and magnesia.	90·74	80·68	74·64	70·31	58·10	57·09	55·49	52·21
Neutral or di-phosphate of lime.	—	—	—	—	—	—	—	—
Carbonate of lime - - -	—	4·26	3·43	10·82	8·80	13·27	13·40	14·32
Lime, with organic acids, silica, and alumina.	4·59	1·83	1·34	·79	—	3·41	—	
Fluoride of calcium - - -	—	·11	5·26	—	—	4·33	1·43	—
Chloride of calcium - - -	1·61	—	—	—	—	—	1·66	—
Phosphate of alumina - -	1·66	—	—	—	—	5·57	5·12	8·89
Phosphate of iron - - -		—	—	—	—	1·78	1·61	
Oxide of aluminum - -	traces	·50	1·03	·60	—	2·14	·80	
Oxide of iron - - - -	—		6·42		—	traces	traces	
Sulphate of lime - - -	—	—	—	—	—	·80	·70	—
Potassa salts - - - -	—	—	0·58	·20	·80	·61	·65	—
Soda salts - - - -	—	—	0·52			—	—	—
Organic matters - - -	—	—	—	8·42	8·60		6·26	8·00
Water—constitutional - -	—	—	—			4·05		—
" accidental - - -	0·43	·20	2·45					3·05
Carbon - - - - - -	—	—	—		19·50	—	—	—
Sand and silica - - -	1·64	12·34	4·83	9·20	4·00	6·93	12·45	13·96
	100·67	99·92	100·55	100·34	99·80	99·98	99·57	100·43

WICKEN (CAMBRIDGE AND BEDFORDSHIRE) COPROLITES.

(*Morfit.*)

Moisture - - -		1·66
Loss by ignition - - -		2·97
Sand, silica, and pyrites - -		24·46
Fluoride of calcium - -		2·02
Sulphate of lime - - -		1·53
Carbonate of lime - -		10·16
Lime (as silicate and organate) -		6·40
Tri-phosphate of lime - -		35·66
Oxide of iron - -	7·56	14·30
Alumina - -	4·07	
Phosphoric acid - -	2·67	
		99·16

COPROLITES FROM PAS DE CALAIS.

(*Morfit and B. W. Gerland.*)

Moisture - - - -		0·610
Sand, pyrites, &c., insoluble in H.Cl.		33·340
Silicic acid - - -		1·490
Fluoride of calcium - -		2·100
Sulphate of lime - -		2·487
Carbonate of lime - -		11·360
Lime, as silicate, &c. - -		7·360
Tri-phosphate of lime - -		29·150
,, of magnesia -		2·552
Oxide of iron - -	2·11	10·541
Alumina - -	2·780	
Phosphoric acid -	5·700	
		100·990

BOULOGNE COPROLITES (*detailed composition*).

(*Voelcker.*)

—	Samples.				
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture - - - - - -	·84	·79	1·08	1·18	1·74
Water of combination and loss on heating - - - - - -	3·14	3·24	3·08	1·91	1·04
*Phosphoric acid - - -	21·06	21·27	21·27	20·70	17·69
Lime - - - - - -	33·06	35·38	33·58	30·41	31·12
†Carbonic acid - - - -	3·55	5·25	4·52	3·94	5·13
Sulphuric acid - - -	6·81	·89	·90	3·24	·85
Fluorine and loss in analysis		2·08	2·77		4·96
Magnesia - - - -	·58	·25	·69	·83	·56
Oxide of iron - - - -	2·89	3·63	3·54	6·24	3·52
Alumina - - - - -	3·09	3·66	3·64	5·39	4·94
Insoluble siliceous matter - -	24·98	23·56	24·93	26·16	28·45
	100·00	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	45·97	46·43	46·43	45·19	38·61
† ,, carbonate of lime -	8·07	11·93	10·27	8·95	11·66

CAMBRIDGE COPROLITES.

(*Voelcker.*)

—	Samples.			
	No. 1.	No 2.	No. 3.	No. 4.
Moisture - - - - - - - -	2·30	3·79	1·19	1·13
Water of combination, &c. - - -	1·50		1·99	2·87
*Phosphoric acid - - - - -	26·05	29·14	25·80	26·15
Lime - - - - - - - -	43·68	45·05	41·47	41·91
Oxide of iron and alumina - - -	18·70	19·68	19·42	17·84
Insoluble siliceous matter - - -	7·77	2·34	10·13	10·10
	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime - -	56·87	63·60	56·3	57·08

Fluorine not given, but most coprolites contain a good deal of this element.

Canadian Phosphates.

(*Voelcker.*)

—	Samples.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Moisture, water of combination, and loss on ignition	·62	·10	·11	1·09	·89	1·83
*Phosphoric acid	33·51	41·54	37·68	30·84	32·53	31·77
Lime	46·14	54·74	51·04	42·72	44·26	43·62
Oxide of iron, alumina, fluorine, &c.	7·83	3·03	6·88	13·32	12·15	9·28
Insoluble siliceous matter	11·90	·59	4·29	12·03	10·17	13·50
	100·00	100·00	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	73·15	90·68	82·25	67·82	71·01	69·85

Spanish Phosphorite (*detailed composition*).

(*Voelcker.*)

Water	3·59
*Phosphoric acid	33·38
Lime	47·16
Magnesia	traces.
†Carbonic acid	4·10
Sulphuric acid	·57
Oxide of iron	2·59
Alumina	·89
Fluorine and loss in analysis	4·01
Insoluble siliceous matter	3·71
	100·00
*Equal to tribasic phosphate of lime	72·87
† „ carbonate of lime	9·31

Rich Bordeaux Phosphate (*detailed composition*).

(*Voelcker.*)

—	Samples.	
	No. 1.	No. 2.
Moisture	2·28	3·28
Water of combination	2·52	1·24
*Phosphoric acid	35·51	33·72
Lime	47·81	44·23
Magnesia	·12	1·74
Fluorine (by difference)	·89	
†Carbonic acid	5·06	3·26
Sulphuric acid	·64	—
Oxide of iron	2·80	2·66
Alumina		6·42
Insoluble siliceous matter	2·37	3·45
	100·00	100·00
*Equal to tribasic phosphate of lime	77·52	73·61
† „ carbonate of lime	11·50	7·40

South Carolina Land Phosphate (*detailed composition*).

(*Voelcker.*)

—	Samples.	
	No. 1.	No. 2.
Moisture	2·78	5·38
Water of combination		1·79
*Phosphoric acid	24·15	24·66
Lime	35·78	37·18
Magnesia	·57	·76
Oxide of iron	3·99	4·15
Alumina	3·20	4·90
†Carbonic acid	2·91	4·08
Sulphuric acid	1·84	not determined.
Alkaline chlorides (common salt)	2·15	—
Fluorine and loss	8·50	2·05
Insoluble siliceous matter (fine sand)	19·13	15·05
	100·00	100·00
*Equal to tribasic phosphate of lime	52·72	53·83
† „ carbonate of lime	6·61	9·27

South Carolina Phosphate.

(*Morfit and B. W. Gerland.*)

Moisture		1·11
Organic matter		1·34
Insoluble, silica, sand, &c.		11·56
Pyrites		1·24
Silica, dissolved by H.Cl (*sic*)		·86
Fluoride of calcium		2·62
Sulphate of lime		4·11
Carbonate of lime		14·02
Lime as organate, silicate, aluminate		9·11
Tri-phosphate of lime		42·13
„ of magnesia		4·43
Oxide of iron	1·83	8·39
Alumina	2·07	
Phosphoric acid	4·49	
		100·92

Sombrero Phosphate.

(*Voelcker.*)

—	Samples.			
	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	8·14	7·03	7·63	8·92
Water of combination		1·64	1·49	
*Phosphoric acid	32·82	32·45	31·70	31·73
Lime	45·33	46·11	45·92	45·69
†Carbonic acid	5·58	7·33	7·30	5·99
Oxide of iron and alumina	7·14	4·29	4·87	7·07
Insoluble siliceous matter	·99	1·15	1·09	·60
	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	71·65	70·84	69·20	69·2
† „ carbonate of lime	12·68	16·64	16·59	13·6

MEJILLONES GUANO. (*Furnished by Burnard, Lack, and Alger.*)

(*Voelcker.*)

Moisture	7·09
Organic matter	7·44
Phosphoric acid	33·97
Lime	37·01
Magnesia	2·83
Oxide of iron	0·69
Sulphuric acid	2·53
Alkaline salts (chiefly common salt)	3·21
Carbonic acid	2·76
Sand	2·47
	100·00

AMMONIACAL GUANO.

(*From Watts' Dictionary of Chemistry.*)

—	African.			American.		
Combustible organic matter, uric, oxalic, ulmic acid, &c.	39·5	37·0	42·59	11·3	36·5	35·0
Ammonia in the form of carbonate, urate, &c.	9·5	9·5		31·7	8·6	7·5
Fixed alkaline salts, sulphates phoshates, chlorides, &c.	7·3	6·5	7·08	8·1	6·5	8·2
Phosphates of calcium and magnesium.	17·5	18·0	22·39	22·5	20·5	22·5
Oxalate of calcium	—	—	—	2·6	—	—
Sand and earthy matter	1·3	0·5	0·81	1·6	1·5	2·6
Water	25·0	28·5	27·13	22·2	26·0	25·0
	100·1	100·0	100·00	100·0	99·6	100·8

ANALYSES of SUGAR SCUMS used at various times by Barnard, Lack, and Alger, Plymouth.

(*From the Laboratory Book of the Firm.*)

1.
From *Liverpool*, ex *Lizzie May*,
February 1873.

Moisture	44·00
Phosphate of lime	11·75
Ammonia	1·18

2.
From Finzel's, *Bristol*,
August 19th, 1874.

Moisture	31·70
Organic matter	28·40
Phosphates	26·00
Ammonia	3·40

3.
From *Bristol*.

Moisture	45·00
Organic matter	17·27
Phosphate of lime	6·16
Oxide of iron	5·46
Carbonate of lime, sand, &c.	26·11
	100·00

4.
From *Bristol*, April 10th, 1866.

Moisture	57·63
*Organic matter	20·44
Phosphate of lime	3·14
Oxide of iron and alumina	2·79
Carbonate of lime	6·17
Sand	9·54
Undetermined	·29
	100·00

* Containing N 1·22 = NH_3 1·48, equal in dry scum to N 2·88 = NH_3 3·49

5.

From *Liverpool*, May 24th, 1875.

*Moisture and organic matter	71·08
†Phosphoric acid	4·90
Lime	7·53
Oxide of iron	5·44
Alumina	
Carbonic acid, &c.	
Sand	11·05
	100·00

* Containing N ·98 = NH_3 1·19.
† Equal to phosphate of lime, 10·80.

6.

From *Liverpool*, April 19th, 1876.

Water	25·82
*Organic matter	30·95
Phosphoric acid	7·14
Lime	11·82
Oxide of iron	9·93
Carbonic acid, &c.	
Sand	14·34
	100·00

* Containing N 1·36 = NH_3 1·65, equal in dry scum to N 1·83 = NH_3 2·22.

The following is an analysis of the dried contents of the filter bags at Duncan's sugar refinery, Victoria Docks, obligingly furnished me by Mr. Newland, the manager, May 2nd, 1877. No blood is used at these works :—

Moisture (water)	3·50
*Organic matter	41·60
Ferric oxide	·72
Alumina	None
Phosphoric acid	2·03
Lime	22·50
Magnesia	1·83
Sulphuric acid	6·82
Chlorine	None
Carbonic acid	11·30
Insoluble residue	7·76
Alkalies and loss	1·94
	100·00

* Containing sugar - 17·80
„ nitrogen ·50

When visiting the sugar refinery of Messrs. McFie and Son, at Liverpool, in May this year, Mr. Marquis, the manager, courteously gave me two samples of sugar-scum, one taken from the filter bags of the Vernon Street refinery, where no blood is used, and the other from those at the refinery in Batchelor Street, where several pails of blood are added to each charge of the "blow-up" pans. The following is the result of analyses of these two samples made by Dr. Dupré :—

—	Moist as received.		Dry.	
	Vernon Street.	Batchelor Street.	Vernon Street.	Batchelor Street.
Moisture	48·58	46·95	—	—
Organic matters	20·82	29·55	40·49	55·70
Mineral „	30·60	23·50	59·51	44·30
	100·00	100·00	100·00	100·00
The mineral matter contains—				
Lime (CaO)	6·19	5·06	12·04	9·55
Magnesia (Mg. O)	0·92	0·34	1·78	0·64
Sand	16·12	10·47	31·35	19·73
Phosphoric acid (P_2O_5)	4·03	2·24	7·84	4·18
Oxide of iron, carbonic and sulphuric acid, &c. &c.	3·34	5·39	6·50	10·20
	30·60	23·50	59·51	44·30
The organic matter contains—				
Sugar	0·24	4·46	0·47	8·40
Nitrogen	0·48	0·89	0·94	1·69
Equal to ammonia	0·59	1·09	1·14	2·06

Comparing these results with the analyses of scum used by Messrs. Burnard, Lack, and Alger, it appears that as respects the only two samples, the analyses of which are so stated as to be comparable with the above, viz., Nos. 4 and 6, the quantity of nitrogen was higher than that contained in the scum from the Batchelor Street refinery, and much higher than that from the Vernon Street refinery, or from that of Messrs. Duncan. The inference to be drawn is that those two samples of scum were from refineries where blood was used, and perhaps the same is true of the remaining four samples. Probably scum from refineries where neither blood nor char dust are used would be of little value to the manure manufacturer. It is remarkable how much sugar was retained (as loss to the refiner) in the sample of scum from the Batchelor Street refinery, as compared with that in the scum from Vernon Street, where no blood is used. But double that quantity was contained in Messrs. Duncan's scum. It is probably a very variable constituent.

Sulphuric acid.

Its ordinary source.

The sulphuric acid used in artificial manure making is universally or almost universally the acid from the leaden chambers in which it is manufactured, ordinarily known as "chamber acid," and having a specific gravity of about 1·45 to 1·6. The acid used for this purpose is now, I believe, invariably made from "pyrites," a sulphide of iron containing usually more or less copper. All large manufacturers of manure make their own acid, sending away the cupreous pyrites subsequently to its being burned, to manufactories where the copper is extracted. Such sulphuric acid is rich in arsenic, which exists in it either as arsenious or arsenic acid, or in both forms. It also usually contains some antimony.

Presence of arsenic.

Since the presence of arsenic has of late been regarded as important in relation to the nature of the fumes evolved in manure making, it is necessary that I should say something more about it here. The most valuable recent contribution to the subject in this connexion is that of Dr. James Adams, of Glasgow,* of whose pamphlet I shall make free use. That arsenic is contained in all commercial sulphuric acid is a fact that has been known to chemists for many years, but Dr. Adams's merit consists in his having brought prominently under notice the fact that its proportion has increased with the adoption of "pyrites" as the ordinary source of the sulphur from which it is made. For full information on this subject I must refer the reader to his pamphlet, where at page 38 there will be found a table of 20 results of analyses of sulphuric acid, mostly chamber acid, 15 of which were made purposely for his inquiry. From a consideration of this table, Dr. Adams infers that 2 to 3 lbs. of arsenious acid per ton of chamber acid prepared from pyrites is a fair average estimate of quantity. One of the results represents an analysis of 432 samples daily taken from 108 vitriol chambers and then mixed together. The acid was exclusively acid manufactured from Tharsis pyrites (the most largely used in Great Britain of any) and "represents the best result as regards arsenical "contamination that a first-class establishment can produce." The analysis was made by an accomplished and trustworthy chemist, and the result was as follows, viz.:

Specific gravity of acid -	- 1·50.
Percentage of arsenious acid -	- 0·0816.
Arsenious acid in one ton of acid	- 1 lb. 14 ozs. 370 grs.

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* On the Presence of Arsenic in the Vapours of Bone Manure, by James Adams, M.D., &c., Glasgow. Edinburgh, John Menzies & Co. (Second edition), 1876.

In two determinations of arsenic in brown acid, specific gravity 1·755, manufactured from Rio Tinto pyrites at his own works, Mr. Burnard, of Plymouth, told me that he found as much as ·520 per cent. of arsenic (estimated as arsenious acid), a proportion equal to some of the largest percentages mentioned in Dr. Adams' pamphlet. Mr. Burnard states his belief that the acid made contains substantially all the arsenic originally present in the pyrites. The quantity of arsenic in chamber acid varies with the chamber from which the acid is taken, being much greater in the first than in subsequent chambers.

Designations of artificial manures.

Artificial manures pass under various designations according to the materials of which they are made. Thus there are "bone manure," where bones are largely used; "superphosphate," where coprolites or mineral phosphates are principal ingredients; "nitrophosphate," where superphosphate is combined with nitrogenous materials, "dissolved guano," where guano is mixed simply with sulphuric acid, &c. There are also known "blood manure," "scutch manure," and "poudrette," &c., &c. It will be convenient first of all to describe the manufacture of ordinary "superphosphate" or "bone manure" and then the various processes by which other principal kinds of artificial manures are made.

Process of manufacture of "superphospate

General description of superphosphate works.

The mineral phosphates have first to be reduced to powder and the bones to be crushed, operations which it is not necessary here to describe. The manufacture consists in mixing them either separately, or more commonly both together in varying proportions with chamber sulphuric acid. I have never in the course of this inquiry seen this operation performed in the open air. It is always performed under a shed, or within buildings specially adapted to the trade. These buildings are often very lofty and extensive, covering one to three acres of land. But few of these establishments can be said to be really on a small scale; some turn out as much as 15,000 tons of manure or more per annum. They are to be met with in all parts of the country. The buildings are usually lighted and ventilated from the roof, or by windows in the side walls near the roof. In passing through them it is usually found that there is one part devoted to the storage of materials, another to the boiling or steaming of bones, another to the drying of bones after boiling, another to the drying of the phosphates about to be used, another to the crushing and screening of bones or phosphates, another to the actual mixing process, another to the reception of the manure as made, another to the various manipulations of additional mixings, or to the sifting and storage of the manure manufactured. And usually these several compartments are so arranged under the same roof at convenient elevations as to promote saving of time and labour. In addition, at most works a portion of the area of the works is devoted to the manufacture of sulphuric acid. The parts which most concern the subject matter of this report are those in which the mixing of the manure is carried on, in which the manure is received after mixing to set and cool, and in which the various subsequent manipulations are carried on.

The mechanical "mixer."

In the early days of superphosphate making the mixing used to be performed by hand labour in an open trough or vessel. But now it is almost invariably performed by machinery. For the most part the mixer (one or more according to the exigencies of the trade done) consists of a covered box, elevated upon a platform or placed on an upper floor of the works, and of such a size as to be capable of turning out from one to five tons at a mixing. It has within it a stirrer, usually consisting of a horizontal iron axis with iron arms, which stirrer is made to revolve by steam power. There are modifications in form of the mixer and stirrer in some works, but, the principle being the same, I need not describe them. It may suffice to say that the closure of the

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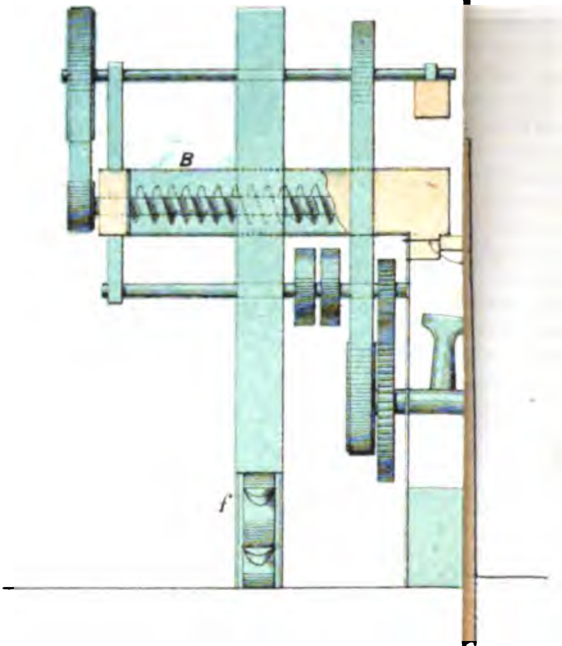


mixer varies in completeness in different works. Sometimes it is completely shut up during working, and sometimes is more or less open at the places where the materials are introduced or where the charge has to be run out. These variations of closure may be important or unimportant as respects the production of nuisance, according as other arrangements are adapted or not adapted to the arrangement of the mixer.

Mixing.

The dry materials are introduced into the mixer first. The way in which they are introduced varies. Sometimes they are thrown in by hand through a hopper at the top of the mixer or near the top on one side. In this case the communication between the hopper and the interior of the mixer may be free and uninterrupted, but in some works there is a valve interposed, and thus, the hopper being kept full, the material, as it is required, is let down into the mixer by opening the valve by an arrangement outside. In other works the materials are carried up from the floor below by means of a Jacob's ladder or endless band provided with cups, and is shot down a wooden channel into the mixer. At Burnard, Lack, and Alger's works at Plymouth, where the mixer represented in Plate 15 is perfectly close and tight, the materials brought from below by a Jacob's ladder are shot into a horizontal wooden channel which the material keeps constantly and completely full, and along which it is carried into the mixer by the agency of a screw working within the channel.

The acid is usually run into the mixer from a gauged tank at a higher level than the mixer, but sometimes from a small measuring cistern at the side of the mixer. The operation of mixing occupies various times at different works. It rarely exceeds ten minutes, (at Morris and Griffin's works, I am informed, the mixing is prolonged to 15 minutes,) and sometimes occupies only three or four minutes. A pastey mass is produced which flows easily out of the mixer, and at the close of each mixing it is discharged into the place devoted below to its reception. For the purpose of discharge the mixer is provided at its lower part (the end or the middle, according to the shape and other arrangements of the mixer) with a flap door capable of being opened and closed by a mechanical arrangement worked from the platform on which the mixer stands.

The "hot-den."

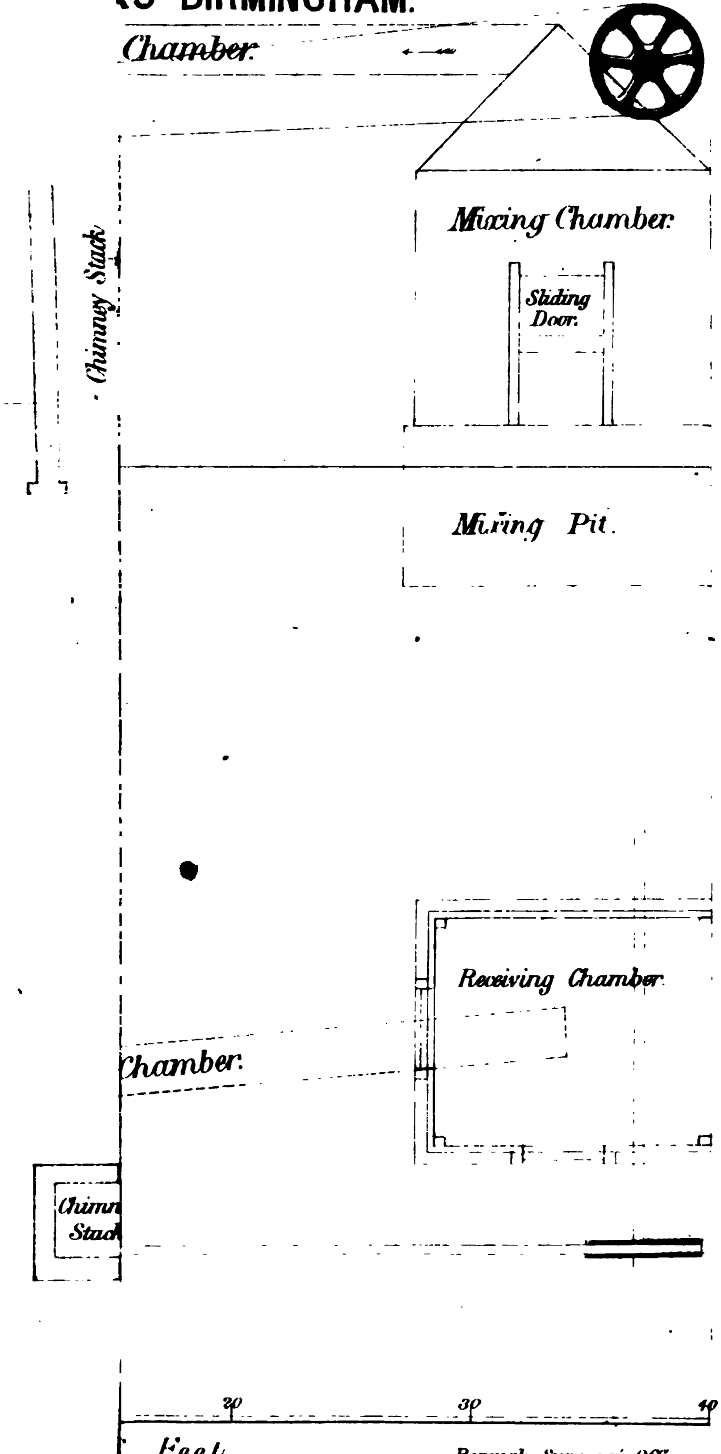
In properly constructed works the manure is discharged from the mixer into a close chamber beneath (either immediately beneath or on one side), which is commonly known as the "hot-den." This chamber is usually constructed of brickwork and has a paved floor. There is a wide doorway which, while the den is being filled and for a varying time afterwards, is kept closed by a firm wooden door or partition fixed in its place by cross bars. The capacity of the den varies in different works, not only its cubical capacity, but also the superficial area of its floor as compared with its height. The lateral walls are commonly provided with openings which are closed by wooden doors or shutters. The roof of the den is sometimes the roof of the building, but in other cases it is formed by a floor or platform above, which can be removed when requisite for ventilation and light, either partially or entirely. The den is usually made of such a size as to hold one day's mixing, but sometimes two or three day's mixing. In some works there is only one den in connexion with each mixer, in other works there are two. In this latter case an arrangement is made by which the manure may be discharged into the one or the other at pleasure. As the manure in its semi-fluid state falls into the den it flows and distributes itself over the floor. The particular materials of the manure regulate the speed with which the fluid manure sets or consolidates. Manure made from materials which contain much lime sets more speedily than that made from materials that contain less lime; the setting quality being due to the sulphate of lime formed. Hence it happens that when materials rich in this ingredient are used, the manure lies much deeper about the spot at which it falls into the den than at a greater distance from it, and, if the floor space be large, will form more of a heap than an even uniform layer. In the den the manure remains to set, and to some extent to cool, and there it remains until the den is wanted for another mixing, or until the manure is wanted for preparation for sale. This period of retention in the den therefore may vary from 12 hours to three or four days, or even longer. When work is actively going on it is the practice in most works to fill the den one day and to dig out the manure the next morning. When the den is about to be emptied the door is taken down, the shutters of the window openings are removed, or the roof of the den formed by the floor above opened out, or skylights or trap doors are opened in the roof of the building when this forms actually the roof of the den. The object of all this is, first, to ventilate the den sufficiently for the workmen to enter, and, secondly, for light. The consolidated manure is then dug out and transferred in barrows, or, at some large works, in trolleys running on tramways, to another part of the building, where it is shot down in a heap for further manipulation.

Mixing by hand. I have now described the usual practice and arrangements met with. But all works are not alike, either in the mode of mixing or in the disposal of the contents of the mixer. Thus the mixing may be performed by hand. This is commonly the case in very small works, where an open vessel is used into which the materials are put, and the whole stirred together with an appropriate instrument. The only large works where I have seen this done in a vessel entirely open are Proctor's works in Bristol. At Proctor and Ryland's works in Birmingham the mixing is performed by hand, but the tank forms the bottom of a chamber, having opposite openings, at which the workmen stand. These openings, as well as a third opening by which materials are introduced, are furnished with shutters and curtains of sacking. Plate 16 shows this arrangement.

At works where the mixing is performed by hand there is no close hot-den, but the manure is at once placed in a heap in some part of the building. At Proctor and Rylands the chamber of the mixer is virtually the hot-den, for I am informed that after the mixing is completed, the manure remains some hours in the mixing tank to cool and for the vapours to be disposed of in the manner to be explained presently. Manure made one day is not removed until the following day, and as there are three such chambers on the premises this can be done, each tank being large enough to allow of six or seven tons being made at one time. But there are other works, even works on a large scale, where mechanical mixers are in use, yet where no hot-dens are provided, but where the manure, as it is made, falls out from the mixer upon the floor of the building, where it is allowed to set and cool before undergoing further manipulation. There are others where the den provided is not sufficiently closed, the barrier put up being just high enough to enclose the liquid manure, but leaving a free space above by which the atmosphere of the den communicates with that of the general interior of the building, or having openings into the external air. The importance of all these variations will appear in the sequel.

Chemical action. Smart chemical action occurs when the sulphuric acid is added to the other materials in the mixer, great heat is evolved, and an abundance of vapour is given off. The action commenced in the mixer is continued after its discharge, vapours continue to be eliminated, and heat to be

PLAN NSING AND CONSUMING VAPOURS
KS BIRMINGHAM.



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Heat evolved.

Vapours evolved.

evolved as the chemical action goes on in the discharged mass. What the temperature actually attained in the mixer or den is I have not been able to ascertain, but it certainly is very considerable. The only observations on the subject that I have been able to find are those of Dr. Adams. He found by experiment in a factory where bones only were being used (in the manufacture of what is known as "dissolved bones") that the heat exceeded 240° Fahrenheit within three or four minutes after the addition of the acid. He made several attempts to ascertain the temperature of the manure within the den, but found it personally dangerous, and was compelled to desist. But it is probably sometimes higher than the temperature mentioned, since Dr. Adams found it to exceed 210° Fahrenheit in a heap of manure which had been left undisturbed for three or four days after leaving the mixer, and 180° in another heap which had been exposed to the cooling action of a fanning machine for 16 hours. In a similar observation made by Dr. Littleton, the Medical Officer of Health for Plymouth, during the discharge of a den at Burnard, Lack, and Alger's works, he found the temperature of the manure over 200°. I am not aware of any analyses of the vapours given off having hitherto been made, other than those contained in Dr. Adams' pamphlet, which were made with the object of determining the quantity of certain specified constituents. Watery vapour is given off in abundance, and fluoride of silicon is formed by the action of the sulphuric acid upon the fluoride of calcium and the silica contained in the materials used. But the fluoride of silicon cannot remain as such in the presence of condensing watery vapour, but is resolved at once into hydrated silica and hydro-fluo-silicic acid :—The following equation shows the nature of the decomposition: $3\ Si\,F_4$ and $4\ H_2O = Si\,O_2,\ 2\ H_2\,O$ and $2\,(2\ H\,F,\ Si\,F_4)$. Dr. Adams has also shown very satisfactorily that the vapours also contain arsenic from the arsenical sulphuric acid used in one form of combination or another. Without doubt some of the arsenic is evolved as arseniuretted hydrogen from the action of the iron of the stirrer upon the acid; but the greater part is probably evolved as chloride of arsenic. The chemical evidence of this fact is to be found in Dr. Adams' pamphlet, and is as complete as could be desired. The quantity of arsenic evolved as chloride will (using the same acid) be commensurate with the quantity of chlorides present in and decomposed with the materials of the manure; and according to Dr. Adams' showing it varies from 2 to 10 or more ounces (estimated as arsenious acid) for each ton of manure manufactured. Under any circumstances it must be an element of the vapours. Antimony, if present in the acid, also passes off in the vapours.

Dr. Dupré's examination of vapours.

By the kind permission of Messrs. James Gibbs, & Co., Dr. Dupré has, for the purposes of this Report, made at their works at Victoria Docks (the arrangements of which are described at p. 270) a chemical examination of the gases evolved during the manufacture of superphosphate from Carolina phosphates. The results of his experiments will be found in his report which, for the sake of convenience, I have placed in an appendix to this Report. They show briefly,—1°. That the vapours evolved contain fluorine in the form of tetrafluoride of silicon, none of it being evolved in the form of hydrofluoric acid. 2°. That the watery vapour evolved is sufficient in quantity to decompose the whole of the tetrafluoride given off with it into silica and hydrofluosilicic acid. The etching of the glass of windows and skylights of the factories, which is very commonly observed, is therefore probably the result of the evaporation of the hydrofluosilicic acid deposited upon them. 3°. That when certain kinds of sulphuric acid are used the gases evolved contain distinct traces of arsenic. 4°. That at these works the greater part of the fluorine originally present in the phosphates employed, and also the greater part of the arsenic of the sulphuric acid, were contained in the superphosphate produced.

The manufacture of superphosphate is chiefly carried on between the months of November and April, but in some large works it continues all the year round.

The manufacture of other kinds of manure.

I may now pass on to the consideration of the mode of manufacture of other kinds of manure, where other materials, nitrogenous or otherwise, are used, either without such materials as are requisite for the manufacture of superphosphate or bone manure, or in conjunction with these materials.

Dissolved guano.

The manure known as "dissolved guano" is prepared by mixing sulphuric acid with Peruvian guano. This operation is usually performed in a mechanical mixer similar to that in use for superphosphate making. It is so made at Mockford's "Ordnance" Works at East Greenwich, where the mixer is capable of mixing six tons at each charge. The mixing is continued about half an hour, and the mixed material is discharged upon the floor of the capacious building in which the operation is carried on. At Ohlendorf's works, which are very large, near the Victoria Docks, there are three closed chambers in the floor, each of which is a circular pit, where the mixing is effected by means of a mechanical stirrer. The mixing of each charge is said to occupy a quarter of an hour, and the mixed material is then carried away in barrows to an adjoining very capacious shed, and is spread out upon the floor to cool. It is said to have a temperature of about 140° when thus spread out. There are abundant vapours given off in this process, and they consist mainly of watery vapour, hydrochloric acid, arising from the decomposition of the chlorides in the guano, arsenic, and some organic substance which imparts to the vapours a cheesy in addition to the acid odour.

Use of leather, shoddy, &c.

Leather and shoddy are commonly acted upon by sulphuric acid separately in an appropriate lead-lined tank, before being mixed with other materials of a superphosphate manure; but sometimes shoddy is used in the condition in which it enters the works and is mixed with the manure after it leaves the mixer. As respects the other nitrogenous materials, including excrement, they are usually thrown into the mixer with the phosphatic materials and mixed all together there. This is the case, for example, at Bradburn's works in Wednesfield, or, if it is not so now, used to be so formerly.

Use of fish.

Fish is sometimes dried or otherwise dealt with before being used. Fish heads (the refuse of fish curing) are in common use for manure. Drying of fish heads is usually performed upon kilns, or heated tiled or stone floors, and a most offensive odour is given off in the process. At Wilmington, near Hull, the fish heads are thrown into a deep bin formed by planking off a part of a shed, shoddy being put in alternate layers with fish, and the whole being freely sprinkled with sulphuric acid. Here the mass remains for 10 days or a fortnight, and the whole is then removed into the country. Whenever the mass appears to heat and evolves visible vapour, it is said that some additional shoddy is laid upon the mass. It is a very offensive process.

Use of blood.

Blood, if in the state of fresh clot, is mixed at once with the other materials, but when used dry it is commonly mixed by hand with the superphosphate on its removal from the den.

"Scutch" manure.

Gluemakers' scutch is usually treated with sulphuric acid and heat, to separate any fat it may contain, before being used for the manufacture of manure. This is sometimes carried out in an open vessel, where the scutch and acid are heated by free steam, but usually in vessels more or less completely closed. As the fat separates it is skimmed off, and when all of it is removed the residue is run off into a bay to cool and consolidate. At Bevington's works in Erith Marshes (and the same was the case at Brown's neighbouring works in 1873) the residue is run off into delves or trenches about 4 feet deep dug in the earth outside the works, where it remains for several months. It is then dug out and dried on kilns or brick flues. At Turner's works, in Bristol, the residue is run into a shallow tank within the building, and as soon as it is solid enough to be manipulated it is dug out and carried in barrows to a heap, partly under an open shed and partly not under cover. At these works the manure thus made is not dried by artificial heat, but is left to dry by spontaneous heating—some that was being screened at the time of my visit was still warm and smoking.

Manufacture of manure from excrement.

Poudrette making.

There is only one place in England in which I have seen human excrement being manufactured by drying into poudrette, viz., at the Town Manure Company's works at Bilston in Staffordshire. The process consisted in adding sulphuric acid to the excrement in the pails in which it came to the works, and then tipping the whole into one of Milburn's dessicators, from which, when it was evaporated to a sufficient consistence, it was removed to a drying floor heated by flues beneath. It was subsequently passed through a mill or disintegrator, and screened preparatory to being packed for sale. At General Scott's works at Saltley, near Birmingham, the excrement similarly received in pails undergoes an elaborate process for its manufacture into manure. The pails are first emptied outside the building upon a strainer so constructed as to allow all the urine and dissolved and fine suspended matter to pass through, but so as to retain any solid fœces, &c. The liquid matter strained off is pumped into an elevated tank for the supply of a boiler. This boiler is capable of dealing with 550 gallons of liquid matter at one charge, and is provided with a stirrer (at present worked by hand) to prevent incrustation. The boiler being charged, 80 lbs. of Dolomite (magnesian) lime is now added, and the whole is distilled by a fire below. The ammonia distilled off is conducted into an ordinary curtained saturator (such as will be described when the subject of the manufacture of sulphate of ammonia is under consideration) containing brown sulphuric acid. The fœtid vapours which are evolved in the saturator are carried through a worm-pipe in the supply tank above mentioned, partly for condensation and partly to warm the contents of the tank before running them into the boiler, and the condensed vapour is run off into the drains. The sulphate of ammonia thus made is evaporated in a shallow open leaden vessel on the top of the saturator, and as it crystallizes is drawn out and set to drain. In this distillation only five-eighths of the ammonia are boiled off. The residue in the boiler, when this quantity has been collected, is run off by a valve at the bottom and mixed with superphosphate obtained from another manufacturer, and is stirred up with it in large wooden vats. The product is then dried either by ordinary means or by pressure. The sulphate of ammonia is added to this as may be required. The solid matters originally separated by straining are mixed in a mortar mill with the ammoniacal phosphate and soot or waste char.

General Scott's works at Saltley.

Manure making at animal charcoal works.

A superphosphate manure is also made from the char dust at some animal charcoal works as an economical mode of utilizing it. Some of the bone oil is also used up at the same time. This is the case at Poynter's works at Greenock. Bone-meal from Buenos Ayres is first rubbed down in a mortar mill with about 8 per cent. of bone oil, and then being mixed with the char dust is run through a continuous mixer (in which sulphuric acid, from sulphur, is added to it) into a den below. To the mixture in the den common salt is added, during which addition copious stifling fumes of hydrochloric acid are given off and fill the upper parts of the building. At Arthur's animal charcoal works near Greenock, where also horse-slaughtering is carried on, all the volatile products of the distillation of bones are mixed with boiled horse flesh, fish, blood, and char dust, partly in the pans in which the flesh is boiled and partly subsequently, and sulphuric acid being added, the whole is laid in a heap within the shed.

Manure making at knackeries.

On four occasions I have met with the manufacture of an artificial manure in association with a knackery. One of these was Kent's, near one of the railways running out of Bristol. The work was carried on in a wooden building within a few yards of the railway embankment. A hole is made in a heap of sweepings and scrapings from factory flues, and blood and flesh from the knackery are placed in it; sulphuric acid is poured on these, and the whole is then covered up with the sweepings. When it is considered that the action of the acid is complete, the whole is mixed up together by hand labour, bones dissolved with acid (from the knackery) are added, and, finally, some shoddy, and the mixture is left in a heap to dry by spontaneous heating, and is finally screened. The other was at a small knackery in the outskirts of Melton Mowbray. The flesh and bones of horses are chopped up and thrown into a cemented brick tank, where they are covered with sulphuric acid, more or less diluted, until they are dissolved or broken down. The more liquid parts are run off by a field ditch into an adjoining brook, and the soft material is removed to a shed where it is mixed into a manure with soot and gypsum. Another was Walton's works near Cambridge—most offensive works; the materials said to be used at the works are crushed bones, coprolites, blood, night soil, horse flesh (sometimes putrid), guts, fish, and refuse salt from the herring curers, liquor from the pans where horse flesh has been boiled, and sulphuric acid. These materials are mixed together by hand, and the mixture is discharged into an open pit within the building. At these premises pigs are also kept in a disgustingly filthy condition. The fourth was Arthur's works, previously mentioned.

Where organic matters containing a good deal of chloride of sodium are used in the manufacture of manures, the vapours necessarily contain more hydrochloric acid than where such substances are not used, and in addition various offensive organic compounds, the nature of which I am not acquainted with.

Effluvium-nuisances.

The offensiveness of the several processes described varies from none at all to that which constitutes one of the most intolerable of nuisances. On different occasions the interference or assistance of the Local Government Board have been solicited for the suppression of nuisances from works of this character. The most notable instances of applications of this kind of late years have been in respect of nuisances from manure works along the shores of the Thames in 1873, and in respect of similar nuisances at Plymouth in 1875. I reported to the Board fully upon the former of these cases in December 1873, but more briefly upon the latter of them, since at that time the present general inquiry had been set on foot. It is difficult to describe odours except by the use of similitudes. The offensive odour proceeding from superphosphate works, from works in which animal matters are used more or less freely, and from "scutch" manure works is, however, so distinctive that once smelt it can never afterwards fail to be recognised. That from superphosphate making is pungent and slightly acid; by some persons it is called sickening, but its offensiveness and sickening quality are enhanced where such animal matters as blood, offal, or fish, especially if putrid, are employed in the manufacture of the manure. I know of no odour more horribly sickening than that which is evolved when sulphuric acid is mixed with human excrement. One of the most offensive works of this kind that has come within my observation, where animal matter of various kinds, and sometimes excrement, are used, is Bradburn's establishment at Wednesfield, upon which I reported to the Board in my report on the sanitary condition of that place in 1874. The smell proceeding from scutch manure works is described by some persons as putrid as well as sickening. Dr. Gordon, the principal medical officer of the Woolwich garrison, described to me the odour proceeding from the scutch manure works on Erith marshes as resembling, more than anything else, that which he had perceived in India when passing to leeward of the places in which the Hindoos burn their dead. To myself the odour resembles that of very decayed and putrid cheese. The odour from superphosphate works has to my senses something of the same character, especially marked when animal matters are used in addition to bones and phosphates. The distance to which the offensive odour may spread beyond the works varies with the various circumstances mentioned in the first part of this Report. It may be only perceived offensively within a radius of 100 yards or less around the works, or the odour may extend a mile or more beyond them. For example, the odour from the works of Morris and Griffin at Wolverhampton is said to be perceived offensively at Newbridge, a distance of 1½ miles; while that from the Erith marshes "scutch" manure works was, on the occasion of my inquiry on the Thames, said to be an intolerable nuisance at the Woolwich barracks, a distance 4½ miles. Loud and grievous complaints are made in the town of Plymouth, especially by persons residing about the Hoe, of the offensive odours from the manure works at Cattedown, a distance of about 1 mile, when the wind blows from that direction across the bay.

Effect upon health.

I have made such inquiries as were practicable as to the effect of these offensive odours upon the health of persons exposed to them. Replies to individual inquiries have been to the effect that prolonged exposure to the offensive odours produces feelings of depression, headache, indisposition for food, nausea, or even sometimes fainting. These, however, are ordinary results in sensitive individuals of the impression made by any specially offensive odour upon the nervous system. They pass off, however, with the intermission of their cause. I have not been able to ascertain that any permanent injury to health has followed even the frequent repetition of exposure to these offensive odours. Nevertheless, so long as the cause operates it does to a serious extent sometimes disturb the health of some individuals. The principal medical officer at the citadel at Plymouth, when I made my inquiry there, could give me no information, as the troops of which he had charge had only recently arrived; but Dr. Yollin, of the 16th Regiment, who was stationed there in 1874, states in a letter given to me by the Town Clerk of Plymouth, that notwithstanding the effluvia pass directly over the citadel in certain directions of the wind, the battalion had not been in a healthier state for the last 10 years than it was at the time he wrote. He adds, "The smell is intensely disagreeable, but luckily the barracks "are constructed on such an elevated and exposed position that these "vapours are never allowed time to settle down, but are blown over it "by the prevailing breeze. Were the barracks, however, built on a much

" lower and more confined space, I have no hesitation in saying that I " should consider the fumes would have a very deleterious effect upon " the health of the troops." Dr. Littleton, the Medical Officer of Health, could give me no more definite information in respect of the effect of the effluvia upon the general health of the civil population; nor could Dr. Finch, Medical Officer of Health for Charlton, nor Dr. Wise, Medical Officer of Health for Plumstead, in respect of the effluvia which, proceeding from the manure factories on the Thames, created a serious nuisance in their districts. Dr. Gordon, of the Woolwich garrison, stated to me in conversation that, in the event of any severe epidemic occurring, evil would, in his opinion, probably result from these nuisances, on the principle that anything which "upsets" the nervous system, predisposes an individual to suffer. But, although I have made a good many inquiries in this aspect of the subject, I have failed to obtain any facts, so far as the ordinary epidemic maladies of the country are concerned, corroborative of this opinion. Dr. Davies, the accomplished Medical Officer of Health for Bristol, distinctly affirmed to me that these diseases spread no more extensively, and are no more fatal in St. Philip's Marsh, where manure nuisances abound, than in other parts of Bristol peopled by a similar class of persons. I am disposed to give great weight to the result of this gentleman's experience, as all would do who know the precision of his work and his logical mind. Moreover, throughout my inquiry, I have as yet found no reason to believe in any opposite view. Dr. Hingston, who has one of the largest medical practices at Plymouth, and has given some attention to this subject, tells me that he has never seen disease (other than temporary disturbance of health such as has been referred to above) produced in healthy people by exposure to the vapours proceeding from the manure works there, but he has seen sick people made materially worse. Especially in bronchitic and phthisical people (who sometimes come to Plymouth for the benefit of the climate), he has observed the cough to become more irritable after exposure to the effluvia. He says further, as to his personal experience, that the fumes from the manure establishments have distinctly caused smarting of his eyes at a distance of half a mile from the works. This, again, is a gentleman whose statements upon such a subject are entitled to much consideration. Further, I may add that I have not been able to discover that the workmen in manure manufactories suffer in any material degree, or in any definite manner, from their occupation. No doubt the statements of workmen on this subject must always be received with some qualification, but in the main I believe they have told me what is correct. But they take care not to expose themselves to the action of the concentrated effluvia. The most dangerous part of their work is the removal of the freshly made manure from the " hot den," but they take care not to work there until all the doors have been opened, and until a free current of air through the den has been established. For myself, what I chiefly experience in the most offensive parts of manure works, such as the den, is more or less smarting of the eyes.

Effects of concentrated effluvia.

Dr. Adams' case.

That exposure to the concentrated effluvia from a bone manure establishment may, notwithstanding, be followed by dangerous and even fatal symptoms appears to be shown by a case narrated by Dr. Adams in his pamphlet referred to above, the occurrence of which case indeed was the occasion of the pamphlet being written. The case, briefly, was that of a gentleman, said to have been in good health, who, while journeying by railway near Inverness, encountered at a small stopping place a volume of vapour, apparently there concentrated, from a bone manure works close by. He immediately became sick and faint, with

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On Effluvium-Nuisances, by Dr. Ballard.

vomiting, which became bilious and continuous, and these symptoms were followed by abdominal pains and great prostration. Feeling better on the fourth day, he attempted to rise, but fainted away and died. It was suggested that this was a case of irritant poisoning from the vapours inhaled, but as no post-mortem examination was made, and as there are many latent bodily conditions of disease conceivable in which such symptoms, followed by a fatal issue, might result from a severe and continuous attack of vomiting (however induced), this view cannot be regarded as established. Dr. Adams goes further, and (p. 23) points out that the symptoms which characterised this gentleman's sudden illness accord with those of arsenical poisoning, but later in his pamphlet (p. 75) he says, "We" (*i.e.*, Dr. Littlejohn, Dr. Dunlop, and himself) "were satisfied that the conditions of advanced age and of the " nervous shock, caused by the inhalation of disagreeable and dreaded " effluvia, were important factors, and had aided materially the depres- " sing influence under which the sufferer succumbed. We, therefore, " by no means attributed the fatal result to arsenic alone. We were " satisfied that if there was to be anything like a real explanation of " Mr. Frazer's symptoms, it must be sought *in that aggregate of con-* " *ditions* out of which they had arisen. In short, we were of opinion, " as was also the magistrate who pronounced upon the case, that com- " mon sense and special professional knowledge alike directed clearly to " the conclusion that the immediate symptoms and fatal results were " due essentially to *irritant poison or poisons*, and that those poisonous " influences were contained in the manure vapours."

Sources of nuisance.

The offensive effluvia from artificial manure works may have their source, 1, in the reception of the raw materials, and their retention or accumulation on the premises prior to use; 2, in the preparation of the raw material for use; 3, in the process of their manufacture or mixing; 4, in the removal of the hot product; 5, in accumulations of the manufactured article, and the general odour pervading manure works at all times, and carried to a distance beyond them by the wind blowing over and through them.

Accumulations of raw material.

1. In accumulations of the raw material.—There is nothing offensive about accumulations of coprolites or mineral phosphates. The ammoniacal odour sometimes perceived from a heap of guano does not travel any considerable distance, so far as my experience goes; leather cuttings are inoffensive, and so in my experience is sugar scum. Large accumulations of recently boiled bones are very offensive, as I have pointed out under the head of "bone boiling"; and the disembarkation of putrid bones from canal boats for use at manure works has, in my experience, been a source of nuisance. Accumulations of night-soil, putrid flesh, putrid blood or blood clot (from blood-albumen works), or of putrid fish, are necessarily very offensive; and so also is glue makers' "scutch," if it arrives at the works long after leaving the pans and in uncovered vessels. This is, of course, especially the case in hot weather. Even dry fish marc (*e.g.*, the dried Manhaddan used at Morris and Griffin's works), not ordinarily offensive, may become so under some circumstances, as when it has become wetted during ship transit. Accumulations of shoddy are ordinarily inoffensive, but they may become offensive under some circumstances, as, for example, when they become spontaneously heated, a process to which they are subject on account of the oil the shoddy may contain. For example, during my visit at Plymouth, I found an offensive rancid butyraceous odour, resembling that which I have experienced as proceeding from a heap of damaged wheat, to proceed from some shoddy recently brought upon the premises of Messrs. Burnard, Lack, and Alger. The shoddy was said to have been damaged

by sea water during its sea passage. The odour was strong just outside the works in the public road, and was disagreeably perceptible for some distance from the works. In one of the works near the Victoria Docks some shoddy was at the time of my visit smoking freely, and emitting an odour of burning animal matter.

The preparation of materials for use.

2. In the preparation of raw material for use.—I have elsewhere referred to the nuisance from bone boiling under the head of "bone boiling." The dissolving of leather and shoddy gives rise to offensive vapours, but not of a nature to be distinguishable outside the works from the other odours proceeding from them. The mixing of fish and shoddy with sulphuric acid is very offensive, and so in a still higher degree is the process of drying fish upon open kilns. These processes are especially disgusting where the fish is putrescent. The vapours proceeding from the extraction of fat from glue makers' scutch preparatory to its conversion into manure has also, when carelessly performed, been productive of considerable nuisance.

Mixing.

3. But one of the chief sources of nuisance from manure works is the process of mixing the materials. The vapours given off are, as I have pointed out above, irritant and offensive. When the manure is made in open vessels, these vapours escape into the atmosphere of the building, and through windows or openings in the roof, or through the unpointed tiling of the roof into the atmosphere outside. The same thing happens, although to a less extent, when the mixing is effected in mixers insufficiently closed, or not provided with due arrangements for drawing off the vapours from the mixer as they are produced. Where the vapours, however, are made to pass, as is now usually the case, through a flue into a chimney, more or less decomposition occurs within the flue, silica is deposited as a white snow-like material (sometimes to such an extent as almost or entirely to choke it up), and, where bones are used in any quantity, bone dust is deposited with it. The bone dust, however, is only carried mechanically into the flue, so that it stains the deposited silica only in the part of the flue nearest to the mixer. The silica and the bone dust deposited mechanically absorb any condensed water holding in solution more or less hydrofluosilicic acid. So much of the vapour as fails to become condensed and deposited within the flue passes off by the chimney shaft, and may give rise to offence wherever the vapours reach the ground.

Removal of manure from "hot den."

4. Another principal source of nuisance is the removal of the manure from the hot den. At some works, as I have already stated, there is no hot den, but the manure is discharged from the mixer directly on to the floor of the building. In such a case as this, the action of the sulphuric acid on the other materials continuing, the same results follow as when the manure is made in an open mixer. When I visited Purser & Co.'s works at Millwall this proceeding was going on at one part of the building, and large volumes of steam of the ordinary offensive odour were issuing from the roof, and would continue so to issue until the manure became sufficiently cold to give off no large bulk of vapour. The principal use of the closed hot den is that it obviates this continued escape of the vapour which is formed during the reactions going on after the manure has been discharged from the mixer. If the manure is permitted to remain long enough in the den to become cold or nearly cold, it may be removed without giving rise to offensive effluvia of a serious character. But in establishments where much work goes on, and especially in the busy season of the year, this is, under present arrangements, said to be impracticable; and the manure is removed hot, or more or less warm, according to the shorter or longer time it has lain in the den; and then the vapours which, under long retention, would have become con-

densed, are given off into the atmosphere, and escape from the den into the air outside through the openings provided for light and ventilation. It is remarkable how long a bulk of manure will remain hot in the den. It is still sufficiently hot to emit offensive fumes on removal at the end of three days from mixing, and probably, in some cases, much longer. I had, when at Plymouth, a personal experience of the nuisance arising from the removal of the hot manure at Norrington's works, at a time when no actual mixing was going on, but when the contents of one of the hot dens were being dug out, carried through the open air to the warehouse, and shot down through the roof. I have some reason to think that at Norrington's lower works this process is more offensive and more productive of nuisance than even the mixing.

General offensive odour from works.

5. But apart from the processes of mixing and removal from the hot den, there is commonly, even when no work is actually in progress, a general offensive smell issuing from establishments of this character which is sufficient in most cases to proclaim their immediate vicinity. This smell, which usually pervades the interior of the building, is due partly to the stirring up of the manure in the manipulations and mixings which take place there, and which favour the escape of pent-up vapours either retained mechanically in the masses removed from the den or which may have been generated after its removal for storage, partly to the odour which from long use has become attached to all parts of the inner surface of the works, and partly to the presence of stores of the manure from which vapours continue for a long time to be evolved. It is, however, a comparatively trifling affair. Nevertheless the offensive odour from this source may travel to a considerable distance. For instance, at my last visit to Hill's manure works on Greenwich marshes, I perceived the odour quite distinctly at a distance of full half a mile in the direction towards which the wind was blowing. On arriving at the works I found that no mixing was going on, but there was a quantity of manure which had been discharged upon the floor on occasion of the last mixing, about a week previously, and was being dug away for screening. It was hard but still warm. The nuisance is much greater, however, in some works where much organic material is used and no deodorant is added to the manure. In "scutch" manure works, such as Turner's at Bristol, where the manure is heaped up to dry by spontaneous heating, the exhalations from the accumulation are very offensively perceptible for a long distance from the works, and, except through changes in the wind, the nuisance is not intermittent like the nuisance from superphosphate works. Even after the manure has become dry enough to be screened, the heating, with evolution of offensive effluvia, still continues. But I am bound to add that this mode of drying, offensive as it is, is not nearly so offensive as the process of artificial drying which I saw pursued at the works on Erith marshes, and which appeared to me to be the main source of the intolerable nuisance from these works which was complained of by the Woolwich garrison.

Modes of preventing nuisances.

I have now to describe the means which have been adopted in the works which I have visited for obviating or minimising the nuisances referred to, and such as have presented themselves to my mind as likely to bring about this result. In establishments where the manufacture is conducted on a small scale, little or nothing is attempted in this direction; and the same may be said also in respect of a certain number of establishments where the manufacture is conducted on a large scale. With respect to some of the latter, however, such as the works at Bramford in Suffolk, and those at Redbridge, Nursling, and Eling, near the head of Southampton Water, it may be said that the adoption of special means of preventing nuisance (considering that, so far as I have been able to gather, no serious injury is done to vegetation by the vapour emitted) is unnecessary. These and similar works located in an open country district with few or no dwellings within a mile or two of them, such as there are being much scattered, can scarcely be much nuisance to anyone. Such places are naturally the proper places for setting up offensive businesses.

1. From raw materials.

1. As to the prevention of nuisances from raw materials. No objection can properly be raised to the bringing of offensive matters to manure works. It is the proper place to bring many of them to, and the utilisation of refuse matters is a source of much wealth. But they should be brought in an inoffensive manner, should be stored so as not to be offensive to the neighbourhood, and used up as speedily as possible. When describing some other offensive businesses, *e.g.*, "glue making," I have shown how the refuse matters from them may be, and sometimes are, transmitted without causing nuisance. The reception of scutch at the works at Erith marshes was some years ago, (when I made a report to the Board upon some offensive business on the banks of the Thames), one source of the nuisance complained of; but since that time one of the establishments visited has ceased to manufacture, and at the other (Bevington's) the scutch is now received fresh at the works, packed in palm oil drums, and closely fastened down. Their transmission in closed barrels or covered carts or barges, and their storage under cover in close buildings or receptacles are, when practicable, an obvious precaution against nuisance. In other cases an efficient protection against the creation of nuisance might be found in covering the offensive material with some cheap deodorizing powder which would not damage the manure to be manufactured from it; sulphate of lime, charcoal in some form, or even earth patted down upon the heap might, for instance, be used. The best modes of dealing with recently boiled bones have been already described under the head of "bone boiling." Night-soil should be should stored either in the covered privy pans in which it is received, or in well cemented pits closely covered, from which it may be pumped as required for use.

2. From preparatory processes.

2. As respects nuisances from the processes to which raw materials are subjected preparatory to mixing them with other substances into manure, I need only refer to the following:—*a.* Any nuisances from the dissolving of shoddy or leather may be minimised or altogether prevented by the use of steam heat in the process, and by carrying the fumes into a sufficiently tall chimney shaft. *b.* The nuisance from mixing fish with shoddy and sulphuric acid may be prevented by performing the process in a closed building from which the offensive air is drawn off through a fire (as practised at Musk's cod-liver oil manufactory at Sculcoats, p. 196). *c.* The nuisances from drying fish can only be abated by adopting means of drawing off the moist offensive air by means of a fan or chimney draught, and conducting it through a fire, or first through a condenser of some effectual kind, and then through a fire. I saw a curious attempt made at Hart's establishment at Wilmington, near Hull, to abate the nuisance of kiln drying. In a building provided for the purpose is a kiln or stone floor heated by flues beneath. It forms the floor of a close chamber, about 13 yards squarea nd 6 feet high, the roof or ceiling of which is made of stout laths or narrow planks of wood with narrow spaces between them. This ceiling forms the floor of a chamber above, on which is laid first a layer of damaged cockles and above this sawdust moistened with sulphuric acid. This layer is renewed once in two or three months, and then goes for mixing with manure. It is supposed that the warm vapours from the kiln

Leather and shoddy.

Fish.

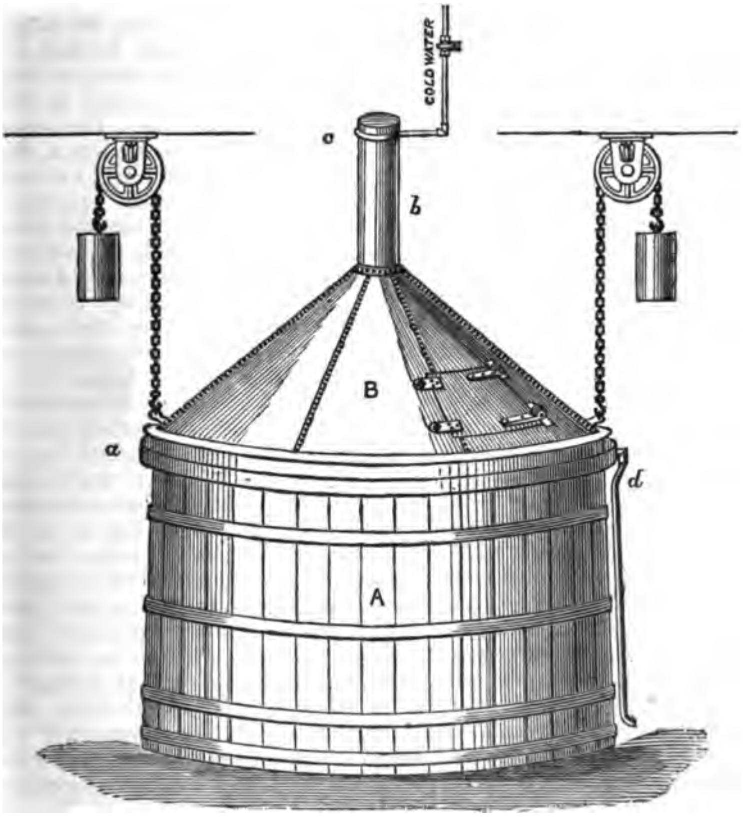
App. No. 6.

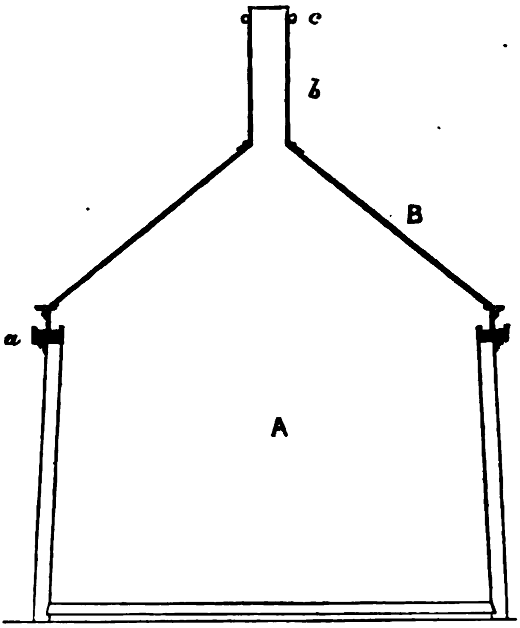
On Effluvium-Nuisances, by Dr. Ballard.

passing up between the laths, and also those from the layer of cockles, are absorbed by the sulphuric acid. To a certain extent no doubt some such action is exerted, but, while the nuisance is considerably lessened, the proceeding does not altogether prevent the diffusion of the offensive smell through the works and in the immediate neighbourhood. For drying fish, probably the best apparatus is Milburn's dessicator, when it is provided with such means of carrying off and burning the evolved vapours as I shall describe presently as having been in use at the poudrette works of the Town Manure Company at Bilston, p. 280. *d.* There are three modes of dealing inoffensively with scutch for the removal of fat, which I have seen in use at different works. The principal point, however, to be attended to is to deal with the scutch at a very early period after it has been removed from the glue pan. One of the methods I refer to is that adopted at Turney's glue works in Stourbridge. The apparatus used is represented in the subjoined drawing and sectional plan(Fig.5.) The scutch mixed with acid is heated by free steam in a large pan A, provided with a rim *a*, containing water, into which dips the edge of a conical cover B, so as to form a water lute when the cover is let down. A short length of pipe *b*, closed at the top, rises from the apex of the cover, and it is surrounded by a ring of perforated pipe *c*, from which cold water constantly flows in a stream over the outside of the cover into the grooved rim of the pan, from which a waste pipe *d* carries it away. By this means the steam within is condensed and runs down the inside of the cover into

Scutch.

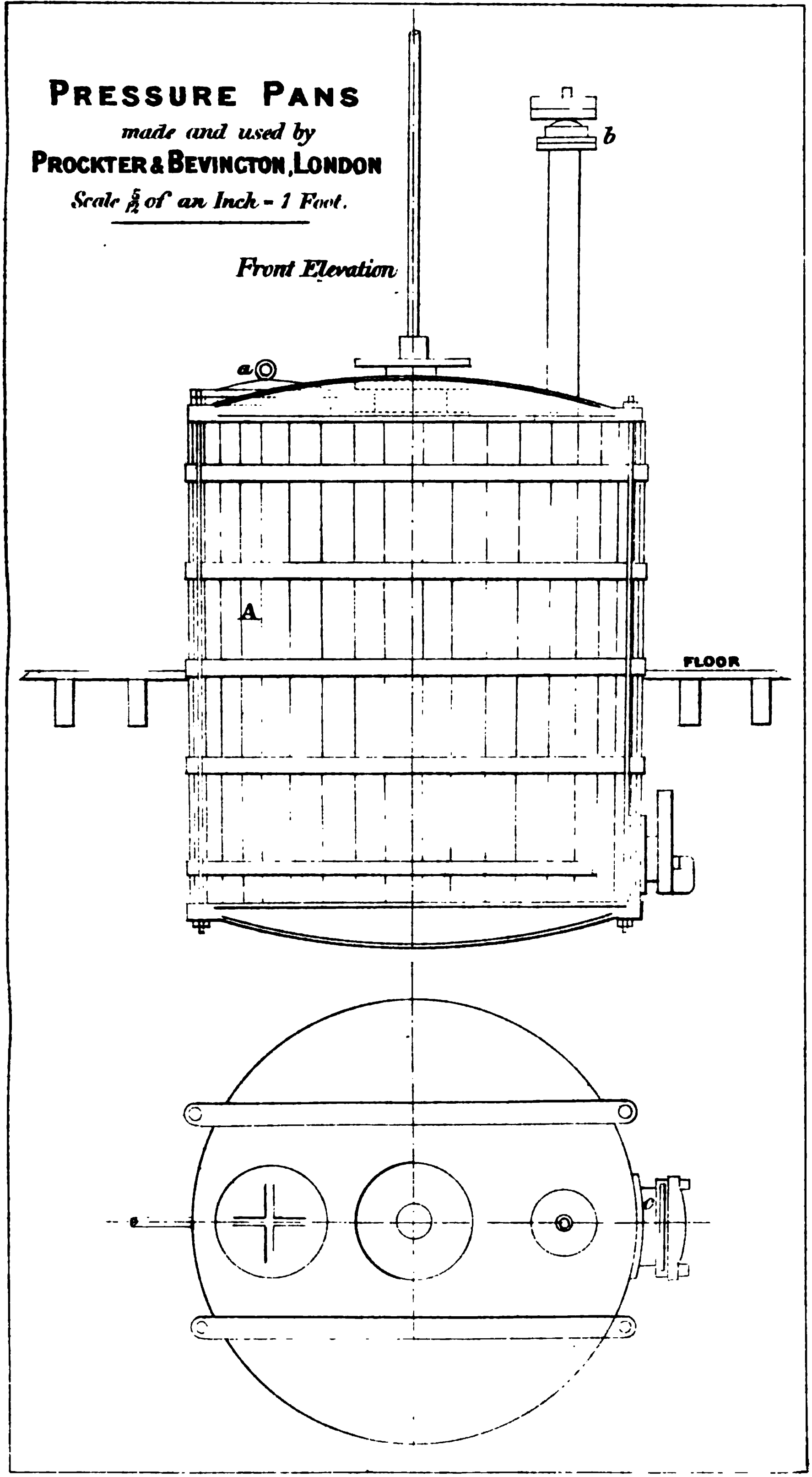
Fig. 5.





the rim. The fat is ladled out and the residue is run off into a covered tank outside the works to cool. Another mode is that now adopted by Messrs. Bevington and Proctor at their scutch works at Erith marshes, one of the establishments complained of as nuisances in 1873. The apparatus used is represented in Plates 17 and 18. The scutch with a due quantity of brown sulphuric acid is introduced into a close cylindrical leaden vessel A, cased in wood and charged through a circular opening *a*, about 18 inches wide, at the upper part, which opening is closed during working by means of an iron cover firmly screwed down. Within is a stirrer B, the shaft of which passes through the centre of the top of the vessel. When the cylinder has been charged and closed up, steam at a temperature of about 220° is thrown in and is left on for about two hours. There is a safety valve *b*, but very little steam escapes by it, not enough to be perceptible by its odour outside the works. At the expiration of the two hours, the steam is turned off and the whole is left to settle until the next day. The fat is then ladled out through the charging opening, and the residue is run off into the delves through a discharge opening *c*, about 14 inches wide and 5 inches deep near the bottom of the vessel. During the steaming this opening is closed by a sliding door fixed firmly down by a cross bar and screws. The only nuisance that can arise here is during the running off of the residue ; but the locality is very open and far from buildings ; and, as a matter of fact, the nuisance from the scutch works on Erith marshes has not been made, so far as I can learn, a subject of complaint, since the scutch has been brought in a fresh condition in well-closed casks and this plan of extracting fat has been adopted. Another mode of dealing with scutch for the extraction of the fat is that pursued at Nickols and Son's works in Leeds. The scutch is dealt with while quite fresh from the pans. It is immediately put into a large tub with water and some sulphuric acid, steam is thrown in to separate fat which is taken off, and the scutch enclosed in coarse bags is then subjected to

Plate 17.



PRESSURE PANS

made and used by

PROCKTER & BEVINGTON, LONDON

Scale 5/12 of an Inch = 1 Foot.

Front Elevation

[illegible] Bedford St. Covent Garden.

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Plate 18.

PRESSURE PANS

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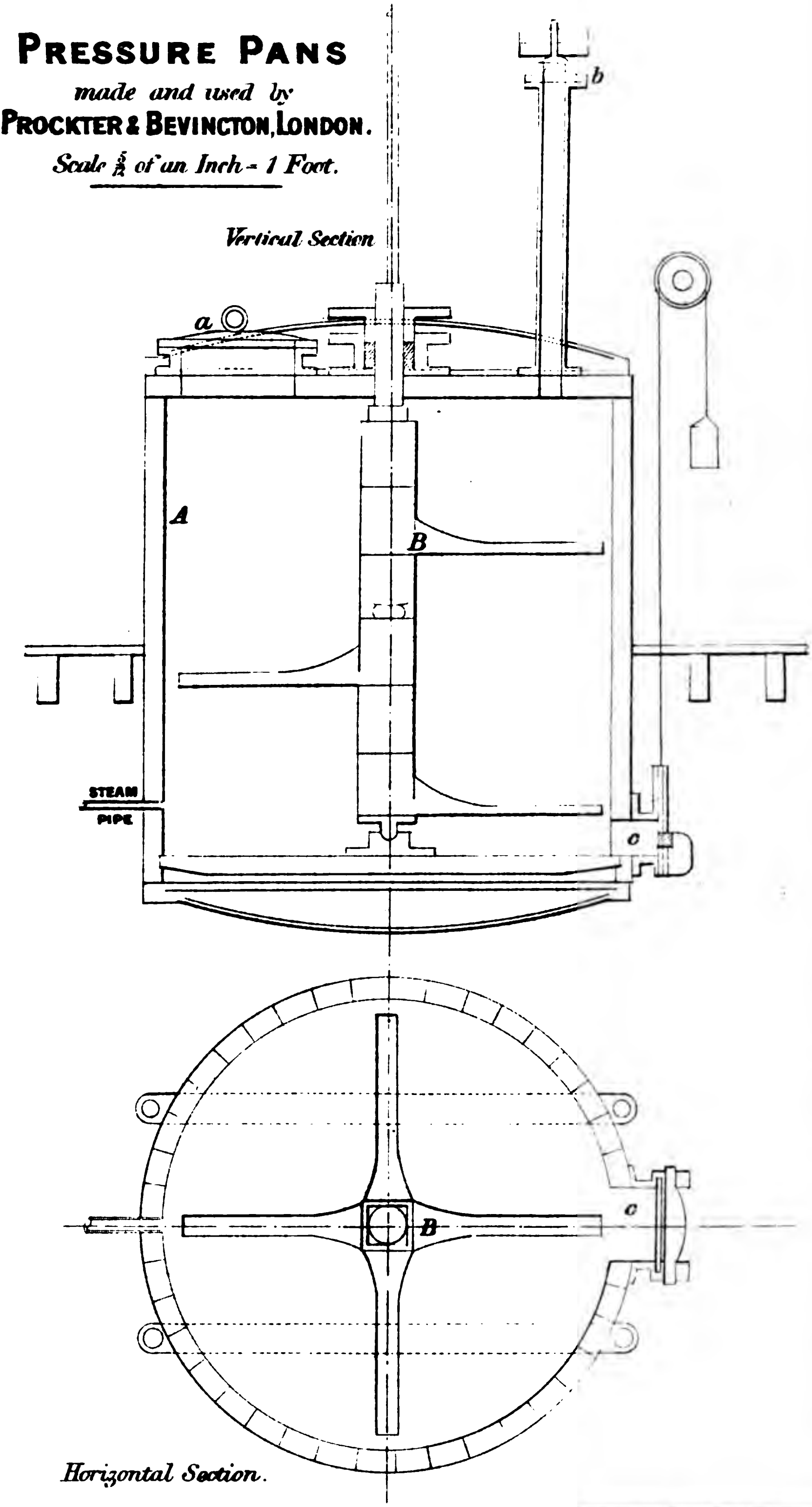
Scale $\frac{5}{12}$ of an Inch = 1 Foot.



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pressure in a strong hydraulic press, close shut up with a door, while steam is thrown into the press. The fat pressed out flows off from the bottom of the press, and is collected and subsequently refined by remelting by steam heat. The pressed scutch has little or no odour, and can be kept without heating or otherwise becoming offensive if stored under shelter. It is still fit for manure making.

3. From mixing.

3. As to the nuisances from the process of mixing. Of the offensive vapours given off during the mixing it may be said that some are condensible by cold, some soluble in, or decomposable by water, and the remainder destructible by fire. The only questions then to be determined relate to the best mode in which these three agents—cold, water, and fire,—can be applied under the circumstances of manure works. The principal means in use in the manure works I have visited are long flues leading to a chimney stack, water towers or "scrubbers," and the furnace. But, when the mixer is not closely shut up, it is not sufficient to have such means provided without some motive power to draw the vapours from the mixer. The motive power in use is sometimes the draught of the chimney stack and sometimes a fan. With a well-closed mixer (such as is in use at Burnard, Lack, and Alger's works), the pressure exercised by the vapour therein may suffice for all practical purposes. I propose to show how far in my experience these several means are efficient, and what accessory arrangements are in use, or may be suggested, to ensure success. I will do this, as far as I can, by examples of actual working.

a. Use of a long flue.

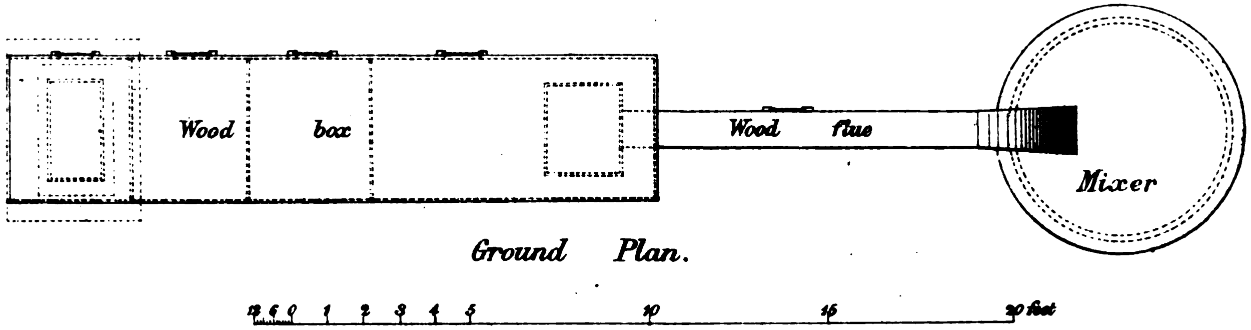
a. In simple superphosphate making, the use of a *long flue* appears to suffice to prevent nuisance. So far as I have been able to ascertain by as full an inquiry as I could institute, it is completely efficient at the works of Thomas Vickers and Sons, in Manchester, and at the works of the same firm at Widnes. The long flue has also been adopted as a means of preventing nuisance at Messrs. Morris and Griffin's works in Wolverhampton and in other works, and as an accessory means it is in use in many other works.

The object of the flue is, by its cooling operation, to promote the condensation of the steam, which, in condensing, takes down with it the hydrofluosilicic acid formed; and to afford space and time for the depositions of these condensed vapours and of the silica, before they arrive at the chimney by which they would otherwise be discharged into the air outside the works. These matters are always found in flues proceeding from large superphosphate mixers and dens, and with them a notable quantity of arsenic. Mr. William Vickers, of Manchester, recently made for my satisfaction an examination of the vapours proceeding along his flues at his Widnes works. At a distance of about 216 feet from his mixer, notwithstanding the excellent arrangements for arresting deposit which I shall presently describe, he still found a very small but still estimable quantity of fluorine compounds, the mixing at the time the examination was made being in full operation. I mention this to show that even in his case the flue is not in any way too long, although it is continued 206 feet further to the bottom of his chimney shaft. Mr. Burnard, of Plymouth, tells me that he found arsenic in the flue leading from his den (which receives the vapours) to his condenser. Dr. Adams also gives in his pamphlet (page 52) a summary of an analysis of flue deposit in which a trustworthy chemist found in the moist deposit 0·119 per cent. of arsenious acid. These are the most irritant of the various constituents of the manure vapours. I have no observations to show in what proportion, actual or relative, they are deposited at various distances from the mixer.

Description of flue arrangements at Vickers' works.

At Vickers' works in Manchester (see Plate 19) a short flue 12 inches square passes from the mixer to a wooden box or chamber, about 18 feet long and 3½ or 4 feet wide and deep, in which at equal intervals are three partitions dividing it thus into four subsidiary chambers or boxes. The partitions spring alternately from the top and from the bottom of the chamber, and there is a space left at the bottom or top, as the case may be, by which the subsidiary chambers communicate. At the bottom of each subsidiary chamber is a door through which the deposited silica or dust is from time to time removed. From this chamber or box there is a communication with the upper part of a brick tower about 14 feet 6 inches high and 2 feet 7 inches wide in either direction, which tower or chamber also has a communication with the "hot den." In this chamber more silica is deposited. There is a shorter brick chamber adjoining it with which there is a communication 4 feet from the bottom of the longer brick chamber, so that the silica which accumulates in the latter, falling below the communication, does not choke it up, and is removeable by a door at the bottom. From this smaller brick chamber the vapours pass into an underground flue 150 feet in length, which terminates in the chimney shaft having an elevation of 210 feet. The result of this is that the silica (the measure of decomposition of the fluoride) is deposited in great part in the wooden chamber and brick tower, the former being cleared out twice a week and the latter once a month; and that beyond the first 15 yards of the flue the amount of deposit is scarcely appreciable. The flue only requires clearing out about once a year. Wherever the silica may be removed it is so wet with condensed steam holding hydrofluosilicic acid in solution, that it may be pressed by the fingers into a paste. At the Widnes works the arrangement is very similar (see Plate 20). A 3-foot square wooden flue, rising from the top of the mixer, extends round the platformed part of the building in which the mixer is situated for a distance of 120 feet before it reaches the brick chamber or tower; and every 8 feet, in the course of the first 84 feet, is a partition rising from the bottom nearly to the top of the flue, so that there are 10 such partitions. The silica deposited in the chambers thus formed is removed at short intervals by raising the top of the flue. The brick deposit tower is of the same construction as at the Manchester works, and from it an underground flue, 3½ feet high and 2½ feet wide, passes a distance of 302 feet to the chimney shaft of the works, which is of an elevation of 135 feet. There is a damper to control the exit from the mixer, to which exit is given an area of a foot to a foot and a half, and there is another over the deposit tower with an opening of about 4½ feet. The wooden flue from the mixer is cleaned out once a week and the first part of the underground flue about once a fortnight. On opening the first part of the flue I found a deposit of about 16 inches, the result of a fortnight's working; and about 96 feet further a deposit of 10 inches, the result of 12 months continuous working. The motive power at both works is the draught of the chimney shaft, and it is sufficient to produce a strong draught down into the mixer when it is opened. Mr. William Vickers sums up the length of flues and the reason of differences at the two works thus in a letter to me: "At Manchester we have, therefore, 22 feet from mixer " to wooden chamber, which is 18 feet long to a tower 14 feet 6 inches " high, and 150 feet to chimney, total length 204 feet 6 inches. At " Widnes 120 feet of wooden chamber (or flue), 18 feet of tower, and " 302 feet of flue to the chimney, total 440 feet. At Manchester we " mix on an average 100 tons of manure per week; and, one half of " the raw phosphatic material being boiled bones, we have not the same

MESSRS. THOMAS VICKERS & SONS.



Ground Plan.

A. Wooden Box B. Brick deposit chamber C Smaller similar chamber
a. Partitions springing alternately from bottom & top of box.
b. Cleaning out doors
c. Communication between the two brick chambers
d. Opening from hot den, regulated by a damper.

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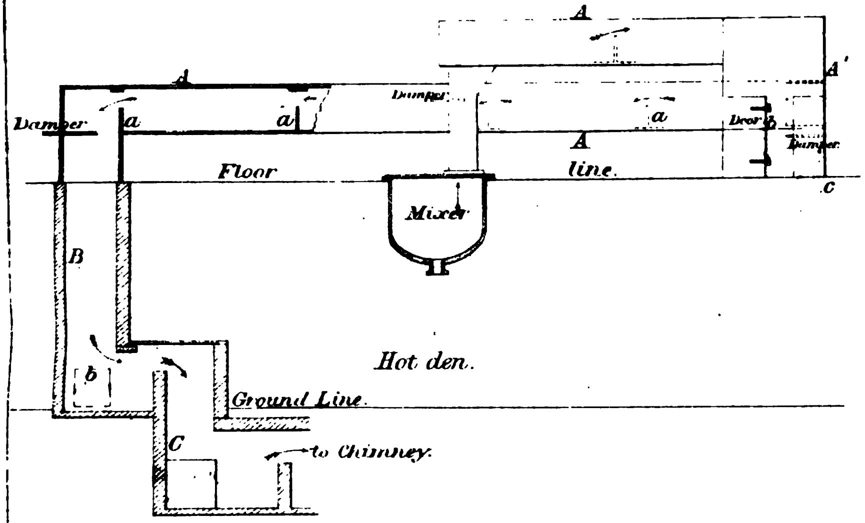
Plate 20.

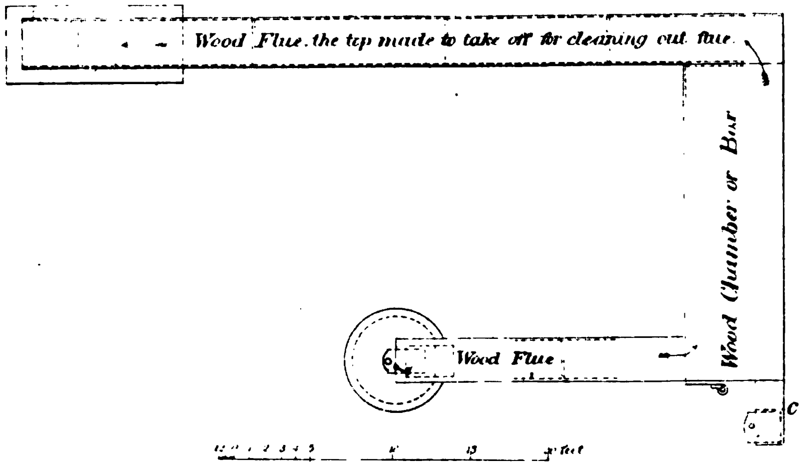
MESSRS THOMAS VICKERS & SONS,

PLAN SHEWING BOX, FLUES &c FOR CATCHING ACID DEPOSIT FROM MIXER AS IN USE AT WIDNES.

VERTICAL SECTION & SIDE ELEVATION.



GROUND PLAN.


Wood Flue. the top made to take off for cleaning out flue.
Wood Chamber or Box
Wood Flue.
c
12 6 0 1 2 3 4 5 10 15 20 Feet

A. Wooden flue enlarged at A' into a sort of Chamber.
B Brick deposit chamber. C Smaller similar chamber.
a. Partitions in flue. b Cleaning out doors c Opening from hot den regulated by a damper.

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Arrangement at Hunt's works.

with a wooden channel which joined another similar wide channel proceeding from the hot den. At a distance of about 3 yards from the mixer this channel communicated with the upper part of a water tower, in which the vapours met with the shower. This tower was constructed of wood, was square with a diameter of 3 feet, and was 18 feet high. At the top of the tower was a cistern which was kept well supplied with water pumped into it in great abundance from a well upon the premises. The floor of the cistern was perforated like a colander with large holes, so that when water was pumped in, it fell down the tower in a heavy shower. It was so arranged that the water, after arriving at the bottom, was made to fall over an edge into a cistern below, in such a way as to form a broken sheet of water or cascade about 3 feet in height (through which the vapour had to pass), and it then flowed away by a brick drain with which the cistern communicated. From this drain there was a flue passing to the ashpit of the furnace of the boiler which works the steam machinery employed for pumping up the water and other purposes. The fall of the water produced sufficient vacuum to cause a strong draught from the mixer and hot den. Since my first inspection of these works, alterations have been made which the proprietor believes have rendered the apparatus more efficient than it was before. A series of wooden shelves springing alternately from opposite sides have been put into the tower and these shelves have attached to them at their sides vertical pieces, having for their object to direct the flow of water towards the middle of each shelf. In this way, instead of one shower of water, a series of splashing showers and cascades has been obtained, through all of which the vapours have to pass on their way to the drain. But with this change in the arrangement of the tower it has been found requisite to interpose a fan between the condenser and the fire. Plate 21 shows the arrangement, with the exception of the fan. Such an arrangement as this is only practicable where there is a similar abundance of water obtainable, but where this convenience exists nothing can be better. At Hunt's establishment the shower is not so heavy. From the mixer, from the hot den, and from all parts of his large buildings where bones are boiled and then dried by spontaneous heating, and where manure is made and stored, wooden square flues about 2 feet wide conduct vapours to a washing tower or chamber and thence to the back part of the ashpit of his boiler furnaces. At these works, however, it is necessary, from the deficiency of draught and the large capacity of the buildings to be ventilated, to use a powerful fan to draw off the vapours. These arrangements, which are quite efficient, were made under the advice of Dr. Letheby and myself some years ago. (See also "Bone boiling.")

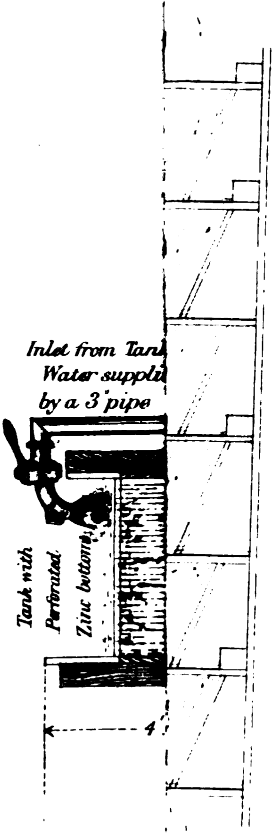
"Scrubber" arrangements.

The use of a "scrubber," however, is far more common than the use of any such water tower as I have just described.

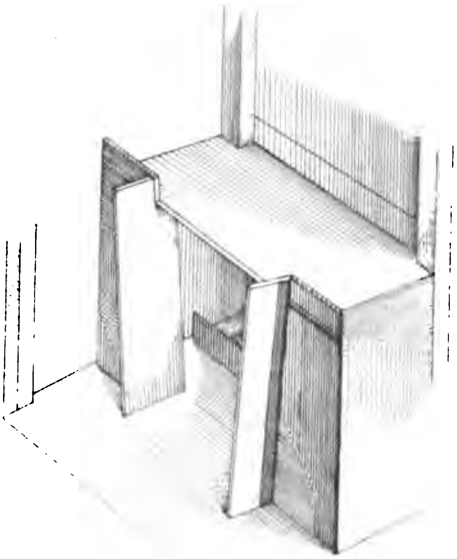
At Gibbs & Co.'s works.

Plates 22 and 23 show the arrangements for condensation at James Gibbs & Co.'s works at Victoria Docks. There are four mixers, two being used for mixing superphosphate and two for mixing guano. From the mixers and from the dens, at the places where the mixers discharge themselves into the dens, are square wooden flues or channels, varying from 133 to 35 feet in length and terminating at a fan. This fan draws off the vapours from the mixers and dens and drives them through the condenser or scrubber. The form and dimensions of the condenser are shown in the drawings. It is fitted within with several stages formed of squared, wooden bars, loosely fitted edge-wise into appropriate racks, and so laid that the rods of each pair of stages cross those of the pair of stages above and beneath, at short intervals. Above is a perforated leaden tray or colander supplied by a tap with water,

NEWTONS WORKS IN BERMONDSEY.



PLAN SHOWING THE SHAPE OF THE OPENINGS FOR THE CASCADES, AS VIEWED FROM THE FRONT OR BACK.



DRAWING OF THE INTERNAL CONSTRUCTION OF THE CONDENSER.

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A. Chimney.

B. the Fan 6 ft. diameter, 2 ft. 6 ins. wide, driven at 350 revolutions per minute. The cover and sides are moveable for cleaning.

C. The Condenser into which the gas is blown from the fan, this is fitted up inside with intercepting bars of wood crossing and recrossing each other at short intervals. These bars rest on a rack also of wood and can all be removed, cleaned, and replaced, by removing the door a.

b. Perforated leaden tray through which the water falls on to the intercepting bars inside.

e. Water tap.

d. Trough or lute into which the water falls from the condenser; and overflows into the pipe f.

D. Wooden flue from superphosphate mixers.

E. Short flue leading from the Condenser to the Chimney.

F. Branch flue 50 yds long leading from guano mixers and entering flue from superphosphate mixers at e

g. Damper

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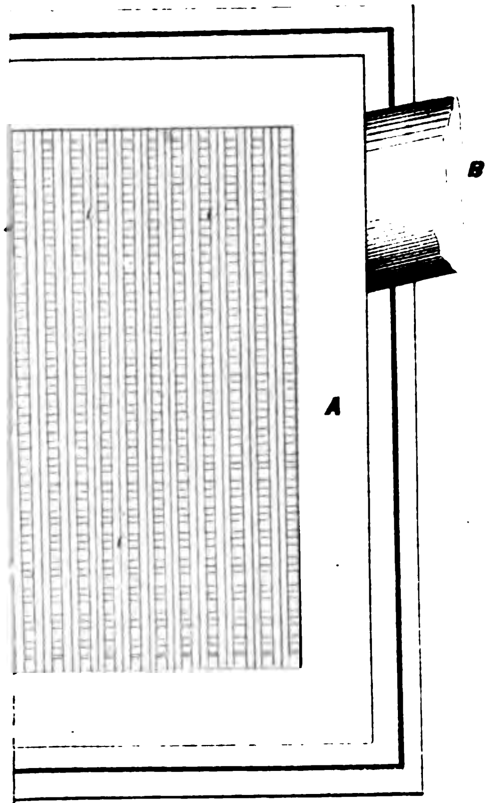

SECTION OF
A DOCKS.

A.A. *Brick of iron bars* **C** *encased in lead. On these bars rest the*
two fi rt set of racks and bars, and the same is repeated to
the to

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TILDEN FOUNDATIONS.

which water falls as a shower upon the intercepting bars within the condenser, and between them to the bottom of the condenser where it runs off to the drains. The vapours enter below and pass out by a short length of pipe above into the chimney shaft. At one side of the condenser is a closely-fitting door, the removal of which exposes nearly all of the interior. When the condenser was thus opened for my inspection, I found a considerable amount of siliceous deposit lying at the bottom of it, and on the several stages. The manager stated to me his opinion that the efficiency of the arrangement depended less upon the flow of water than upon the obstruction afforded in the condenser to the passage of the vapours, affording time for the decomposition of the fluoride, and arresting the products of the decomposition. Nevertheless it would be certainly less efficient than it is without the flow of water which serves, or ought to serve, to keep the passage between the bars free and to wash down condensed matters. It was at these works that Dr. Dupré made the observations recorded in the Appendix to this Report. He found that the gases after having passed the scrubber contained no appreciable traces of any fluoride compound, but they still contained traces of arsenic.

There is a very similar arrangement at the works belonging to the same firm at Plymouth. Here the mixer is near the end of a long building, and discharges into a den at the end of the building, the communication between the mixer and den never being quite closed. A short channel from the mixer conducts the vapours from it and from the den through the mixer to a fan which drives them along a 2-feet square wooden flue or channel, about 90 feet in length, to a condenser arranged similarly to that just described. About every 10 feet in the length of this flue is a cover, screwed down, which is removed, it is said, about once a month for the cleaning of the flue from deposit. The condenser generally arranged with bars as in the London works, is differently arranged above. The vapours pass out through a channel which runs through the middle of the colander-like cistern above, by which water flows into the condenser. The colander, therefore, is ring shaped. While the condenser was open I had the water turned on, and found that very little flowed in consequence of the choking up of the holes in the colander. The foreman told me that they were quite aware of this defect, and that each time before working the holes were cleared. I have no doubt that this was a correct statement, since, although the condenser had not been cleaned out for a fortnight or three weeks (notwithstanding that work had been going on during that period) there was very little deposit in it—very much less than in that at the London works. This smallness of deposit was no doubt in part due to the greater length of the flue. From the condenser a flue, 16 feet in length, leads to the chimney shaft. It had not been cleaned out for two months, and I found in it along its whole length a deposit about one inch in depth. Hence some of the vapours must have escaped by the chimney stack, 80 or 90 feet high, although the greater part had evidently been arrested.

At Burnard, Lack, and Alger's works.

The most complete and apparently most effective "scrubber" I have yet seen is that in use at Burnard, Lack, and Alger's works at Plymouth.

Since these works have been made the subject of much unfavourable comment in Plymouth, and have been there regarded (and, as I believe, not very justly on all occasions) as the principal source of the manure nuisance complained of at the Hoe, and referred to in the memorial presented to the Board, I propose giving a full account of the works, while describing the efforts made by the proprietor to avoid the production of nuisance. I have visited the works four times with an interval of a year between my second and third visit, and have altogether spent many hours in the works. The works in Sutton Road have been established about 16 years, and cover about two acres of ground. They are situated, in two parts, one on the north and the other on the south side of a public roadway, at the edge of the town, and close to the gas works, some ammonia works, some tar works, a candle factory where palm-oil is distilled and fat melted, and also a most offensive shoot of town refuse belonging to the Corporation; that is to say they are close to a number of other offensive business establishments, the effluvia from which must also be wafted towards the town when the wind carries the manurial vapours in that direction. It is, therefore, quite possible that persons not sufficiently instructed to distinguish between different industrial nuisances, may sometimes have attributed to the manure works a nuisance which may really have had a different origin. I was informed by the firm that the materials which they use (varying them according to circumstances) are crushed bones (foreign), Carolina, Lisbon, and French phosphorites (chiefly), coprolites, Peruvian guano, shoddy, sugar scum, and gypsum. The sugar scum has in the mass a sweetish odour not at all unpleasant. Manure making is mostly performed on the north and south sides alternately. On both sides the mixer is of the same construction. It is a close box with the usual stirring arrangements, and it is fed through a channel packed full of dry material which prevents any exit of vapour in that direction, and which is moved on by means of a screw working in the channel as described in an earlier part of this section of my report. The acid is introduced in definite quantities by a pipe from the acid tank. No vapours can possibly escape from the box during mixing, or if they ever do, only quite accidentally. There is one close den below the mixer on the north side. It measures in superficial area 35 feet × 27 feet, equal (with the corners cut off) to an area of about 800 feet, with a height of 12 feet, and is capable of containing 200 tons of manure—one or one and a half day's working. It is closed completely during the mixing by means of a large wooden door firmly barred up. On the south side there are two dens associated with the one mixer, and there is an arrangement by which the contents of the mixer may be discharged into one or the other as may be desired. These dens are capable of containing each about 90 tons of manure, and they are worked alternately. Each is roofed above by a wooden flooring, which at the time of working is sealed against escape of vapour, (and, as I took pains to ascertain, effectually) by a layer of dry materials. When closed the superficial area of each den is about 20 feet × 11 feet, and the height 14 feet. The mixing of each charge occupies about four minutes, and the mixed manure is discharged into the den by a valve worked from outside the mixer. There was no unpleasantly perceptible odour about the mixer while it was at work. I may now proceed to describe the condensing arrangements, premising that on both sides the manure and the vapours evolved are both made to pass into the den, which thus becomes a first large receiving and partly a condensing and deposit chamber for them. So much of the silica and hydrofluosilicic as condense there becomes mingled with the manure, and would exist there probably as hydrofluosilicic acid and silica only. Beginning my description with the works on the north side: There is, proceeding from the den, a short length (2 feet 6 inches) of 12-inch pipe leading from it to the condenser; and from the condenser there is an underground flue 50 feet in length leading to a fire. The condenser is constructed as shown in Plate 24, and is of the form and dimensions there indicated. It consists of three vertical chambers

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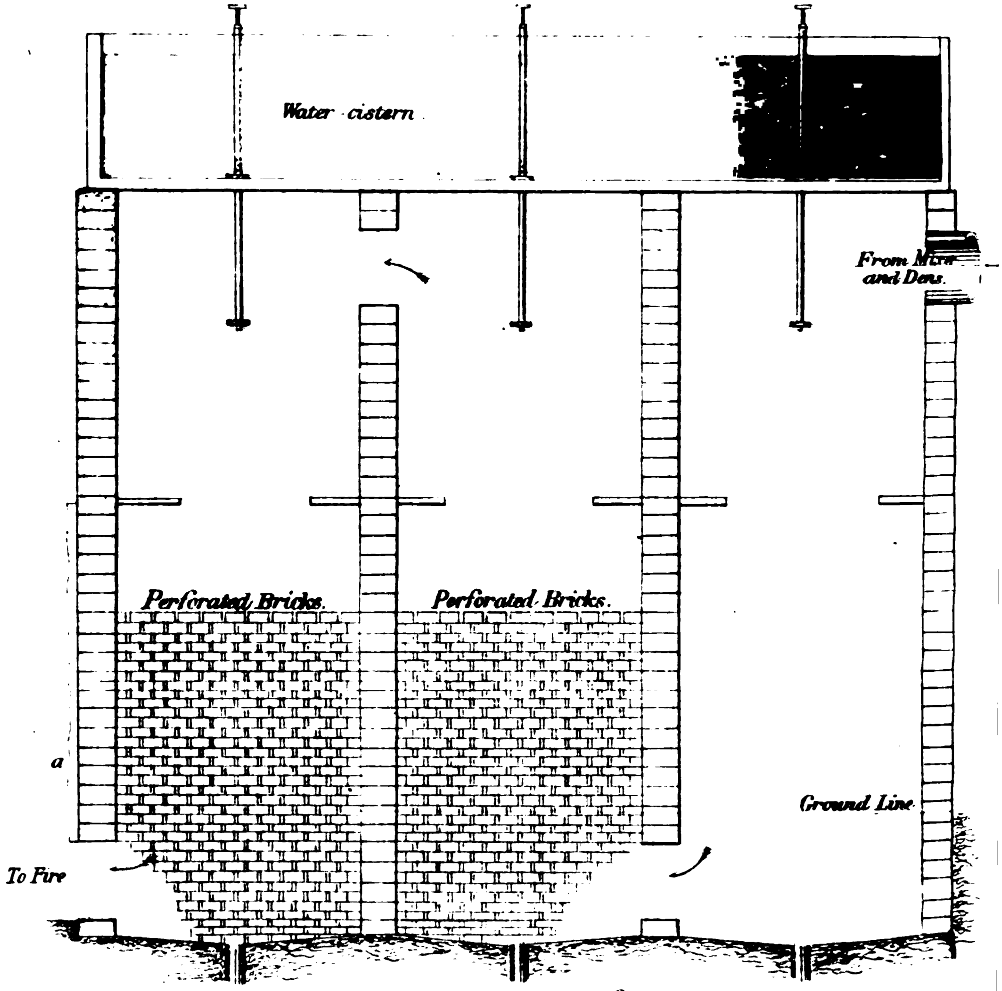
Plate 24.

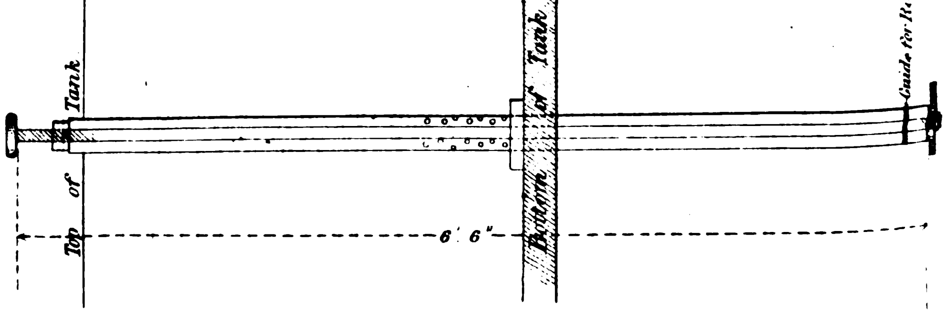
CONDENSING APPARATUS
in use at
THE PLYMOUTH CHEMICAL WORKS
BURNARD, LACK AND ALGER.

Section of Towers.



Scale $\frac{1}{4}$ inch to the foot.

ENLARGED SECTION OF WATER DISTRIBUTER.



brick. The first contains nothing, but the second and third have at their lower halves perforated bricks, evenly but not too closely laid. Above is a tank well supplied with water for use in the condenser. There is an excellent arrangement for throwing in the water into the condenser. It flows by a pipe into each compartment. The bottom of the pipe is open, but capable of being closed entirely by means of a plate or button which can be raised against the opening by a screw working through the length of the pipe from above. When this plate is slightly lowered the water flows out in a thin sheet resembling an open umbrella in shape, and falls down through the chambers and loose perforated bricks at the bottom, whence it is carried away by the drain. The arrangement of the supply pipe is shown in Plate 24. After each working, a plug in the cistern above is opened, and a flush of water is sent through each chamber to clear it of any deposited silica. The vapours from the den enter the upper part of the first chamber, pass into the lower part of the second chamber, between the bricks, and enter the third chamber above the sheet of water through which, or through the spray from which, they must pass out among the bricks below to the underground flue leading to the fire. I examined this condenser while mixing was going on. In the first chamber the vapours were overpowering above the sheet of water; while in the second and third they are decidedly much less perceptible. The next day, when no mixing was going on, I had the third chamber opened below at *a*, and also the first 5 feet of the underground flue leading from it, and again another part of the flue about 34 feet from the condenser. The bottom of the condenser had not, I was told, been opened for five years, yet all I found was some slimy deposit upon the bricks, the passages through and between them being quite clear. There was no siliceous or watery deposit at either part of the flue which I had opened. I could not, however, satisfy myself that the fire exercised much effectual traction upon the vapours in the den; probably, therefore, the vapours passed through the condenser chiefly by force of their own pressure, such as did not so pass being condensed within the den. Were it not, therefore, for the careful closure of the mixer, there would have been during mixing much escape of vapour into the building, but this is obviated in the manner I have already explained. The arrangements on the south side are a little different, although essentially similar. The two dens communicate by a 12-inch pipe from near the roof of each with a deposit tower. The length of the pipe from the nearest den is about 2 feet, of that from the further den 20 feet. The tower into which they open at its upper part is 2 feet square (internal measurement), and its total height is about 15 feet, and it descends about 4 feet below the level of the floor of the works. From the bottom of this tower, an underground flue 44 feet 6 inches in length leads to the condenser. During the greater part of its course it is of brick 2 feet high (internal measurement) at first, but gradually narrowing towards the condenser to 1 foot 8 inches high, and 2 feet wide in the greater part of its course, again becoming larger and higher still, so as to form a small deposit chamber just before opening by two 12-inch square openings into the condenser. But between these two parts and about 6 feet from the condensers there are interposed two 12-inch pipes in order to permit of another underground flue crossing this flue. The condenser is here constructed of two chambers only, the first (in consequence of the length of flue) not being considered requisite. Both of the chambers contain perforated bricks; in other respects the condenser resembles that on the north side. The flue leading to the fire is very short, indeed the fireplaces re built in this case against the side of the condenser. The fireplaces are constructed as shown in the drawing, Plate 25. There are two of them, and the flues are provided with dampers so as to direct the vapours to one or the other fire as may be desired. The object of having two fires is as a provision against one of them being accidentally extinguished by the vapours. The flue from the fires enters the bottom of the chimney shaft 100 feet high. I was informed that, in working this arrangement of duplicate dens, the flooring forming the roof of the den filled the day before is partially raised, and a cap is placed upon the opening of the pipe leading from it before the filling of the other den commences. I examined the two pipes, lower flues, and condensers in their whole length. There was very little deposit in the pipes leading from the dens. The tower was encrusted with siliceous deposit, of which there was a deposit 1 foot deep at the bottom. At a distance of about 30 feet from the tower the deposit was 6½ inches deep; in fact it came just up to the lower edge of the interposed pair of pipes. There was very little deposit in the short pair of interposed pipes, and very little again in the wide part of the flue near the condenser: but this part is cleaned out monthly. I was told that the tower and first 30 feet of the flue had not been opened for more than 12 months. The lower part of the condenser had not been opened for two years, and the appearance it presented differed in nothing from that of the condenser on the north side. There was no deposit whatever in the short length of flue leading from the condenser to the fire, and nothing but ordinary flue dust or soot in the flue leading from the fires to the chimney stack. This fact indicates sufficiently clearly that no condensible vapours had escaped the action of the scrubber. By an arrangement provided for the purpose, the whole of the products of combustion in the fires were made during a period of mixing to pass for a time through and out of a testing chimney shown in the drawing. They had no odour of manure vapours, nor any other odour than that ordinarily proceeding from the combustion of coal or coke.

In a letter from Mr. C. Burnard, dated April 10, he tells me that, although he found arsenic in the deposit within the flue leading from the dens to the condenser, he did not find the slightest traces in the flue stuff at the bottom of the chimney, *i.e.*, after the vapours had passed the condenser; and further, that during the mixing of a large den on Feb. 14 last, he caused the chimney gases to pass through a weak solution of hydrochloric acid for about four hours, and could not, by the most delicate tests, discover any presence of arsenic.

The efficiency of the arrangements at these works for collecting and condensing, or burning the vapours produced during mixing, and those evolved during the first few hours of retention of the manure in the den is thus, in my opinion, incontestible.

At Norrington's works, Plymouth.

I have described the condensing arrangements at James Gibbs & Co.'s works. The remaining manure works at Plymouth are situated, close to Gibbs' works, at Cattedown, about a quarter of a mile beyond the works of Messrs. Burnard, Lack, and Alger, and outside the town. These works are known as Norrington's works. There are two sets of works, viz., a set at a lower and another at a higher level. The materials used are said to be phosphatic guanos, French and other mineral phosphates, and dry (foreign) bones. At the lower works there are two mixers of the ordinary construction fed through a valved hopper at the top, and each having a short shoot into a hot den well closed in during mixing. The period of mixing each charge (about 1 ton) is said to be from 5 to 10 minutes. Both from the mixer and the den a wooden flue, 2 feet 6 inches square, conducts the vapours to outside the works, where it is replaced by a stone flue of similar size. This leads to a condenser: the length of flue from the mixers to the condensers being

Plate 25.

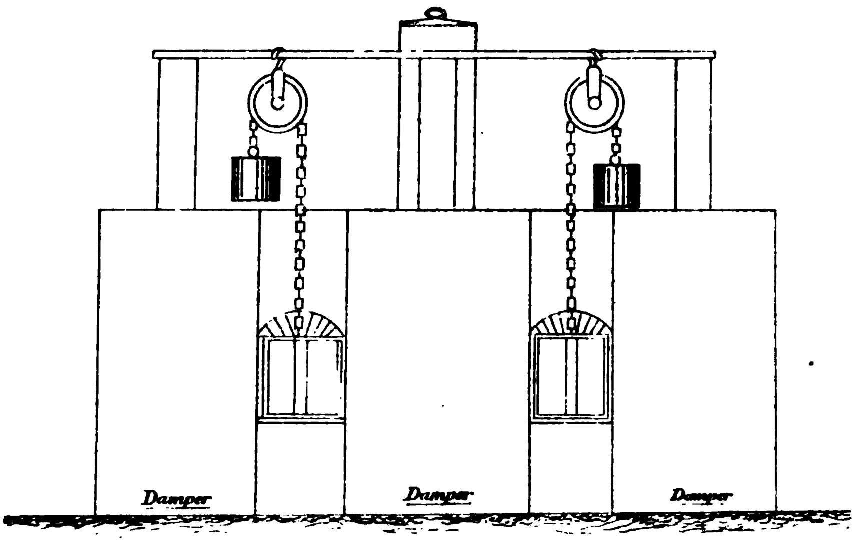
PLAN OF FURNACES FOR CONSUMING OFFENSIVE VAPOURS:

in use at

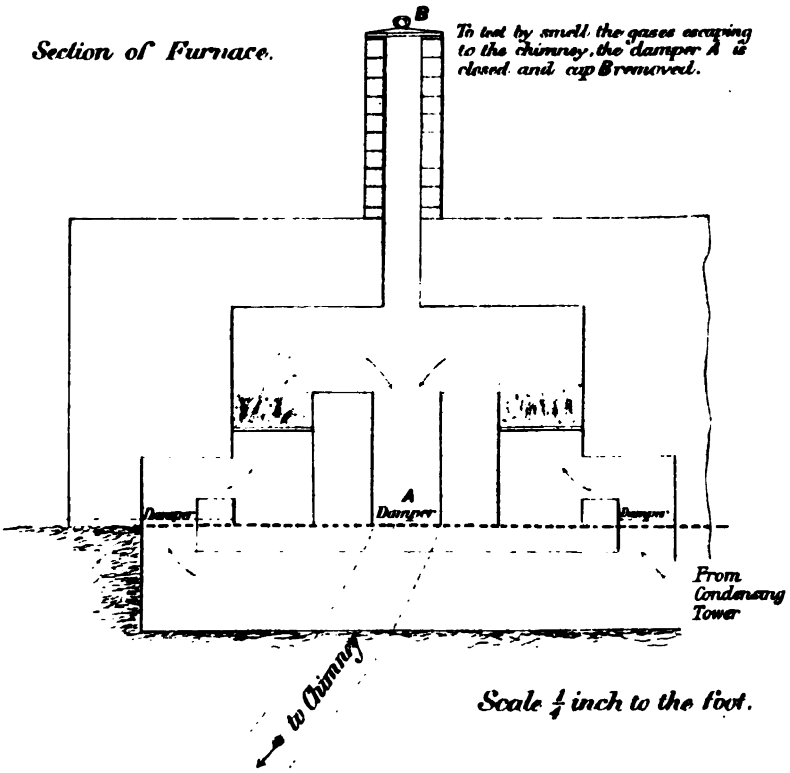
THE PLYMOUTH CHEMICAL WORKS.

BURNARD, LACK AND ALGER.

Elevation of Furnace.



Section of Furnace.



To test by smell the gases escaping to the chimney, the damper A is closed and cap B removed.

Scale $\frac{1}{4}$ inch to the foot.

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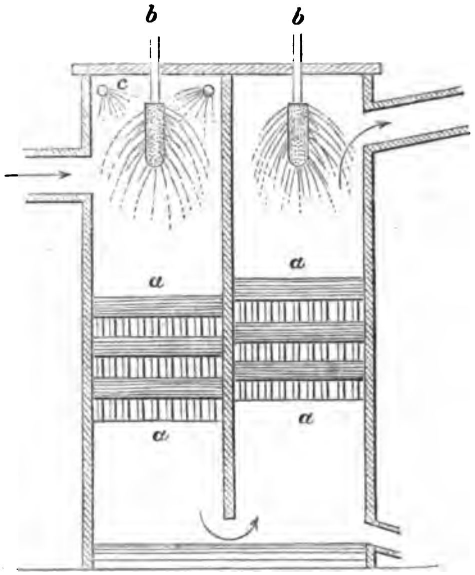
App. No. 6.
On Effluvium Nuisances, by Dr. Ballard.

about 60 or 70 feet. From the condenser another flue passes up the side of the cliff, beneath which the works are situated, to a comparatively low chimney shaft on the top of the cliff: the distance from the condenser to the top of the shaft is said to be about 150 feet. The condenser is a closed brick tower about 15 feet high, about 10 feet long, and about 5 feet wide, divided vertically into two chambers. Each of them contains a series of wooden frames *a* made of deal planks set on edge, with intervals of about 3 inches between them. These frames are placed alternately, so that their vertical planes cross one another, and so that, on looking down the condenser, square channels appear to be formed all the way down. The following diagram (Fig. 6) is intended to show the kind of arrangement within the condenser; the arrows show the course of the vapours :—

Fig. 6.



Each condenser is supplied with water by a 1-inch pipe *b* passing through the middle of the roof, and terminated below by an elongated or cylindrical rose, which is intended to throw out the water in a shower upon the wooden stages beneath. In addition, there is a perforated pipe *c* running round the top of the first chamber. The water flows into the pipes under some pressure, being regulated by a tap in the general supply pipe. The spray thus produced was a fine spray, and in amount insufficient, in my opinion, to produce any considerable cooling or washing effect upon the vapours. Beside this, what struck me in the working of the rose was, that the spray of water did not fall downwards upon the wooden frames, but horizontally outwards against the sides of the brick chamber, along which the water flowed to the bottom, and then ran off. Really the only water which, so far as I could see, reached the middle of the framework was that which, in the first chamber, flowed from the pipe round the top, while the fumes from the flue entered below the level of the horizontal shower. Moreover, some of the perforations of the roses were choked up with rust or silica, and nothing flowed from them. Examining the arrangement during mixing time, I found vapours distinctly perceptible to sight and smell passing into the flue beyond the condenser. About 10 feet beyond the condenser, at a place where the flue is capable of being uncovered for cleansing, I found a deposit of at least 6 inches in depth of siliceous matter, and the sides were incrusted with deposit, but to a much less extent. The manager told me that this part of the flue was cleansed about a year previously. In fact, the conclusion to be drawn is that, so far as the condenser is concerned, it exercises little influence upon the passage of the vapours, the chief protection to the neighbourhood being the length of flue. But even as respects this, however tardy the flow along the flue may be for the first 80 or 90 feet, it must be much more rapid from that spot to the top of the chimney shaft, since here the vapour flue is joined by the flue from the furnaces. The condensing arrangements at the upper works are similar, but here the flue from the mixer to the condenser is only 10 feet long, and the vapours after leaving the condenser pass with a very small interval into a chimney. There appears to me to be still less protection to the public against nuisance from this than from the lower part of the works.

c. Use of a fire.

c. When organic or nitrogenous matters enter into the composition of the manures, the offensive vapours proceeding from them in great part escape condensation either in the flue or by the action of water in a scrubber. It is therefore necessary in such cases, after such condensation as can be effected, to pass the vapours through a fire, so as to burn up any offensive organic matter they may contain. It is with this object that Burnard, Lack, and Alger superadded a fire to their condensing apparatus. The sugar scum they use gives to the manurial vapours, in addition to their acid pungent odour, a sweet smell of a somewhat ethereal character, and such as is objectionable to many persons, although not particularly so to myself. Where fish, excrement, blood, or garbage are used in the mixers, nothing but the best arrangements for combustion will deprive the vapours of their disgusting odour.

Relative value of flues and condensers.

Let me now endeavour to sum up the results of my observations on manure works, so far as they apply to the relative value of long flues and washers or scrubbers for arresting the escape of offensive vapours into the external atmosphere.

There is no doubt upon my mind that (except where offensive organic vapours are concerned) a sufficiently long flue, properly arranged and carefully managed may, under favourable circumstances of locality, constitute a full protection to the public against the nuisances proceeding from the process of mixing.* The flue is to be regarded as an elongated cooling chamber, affording facilities for the decomposition of the fluoride of silicon by the watery vapour present, and the deposition of condensed matters. But if the vapours pass through it too rapidly they may fail to be sufficiently cooled and condensed before arriving at the end of it. The flow of the vapours along it should be deliberate; and where the mixer is open, and hence where some motive force must be applied to draw or drive them along, the force should be just as much as will suffice to occasion a moderate in-draught to the mixer and no more. Hence I have been led to think that the use of a fan is sometimes, by causing too rapid a current in the flue, rather an injury to the condensation than otherwise: hence, too, when a chimney draught is used it ought to be judiciously regulated by a damper. Hence, again, the advantage of the baulks or mid-feathers introduced by Mr. Vickers into the first part of his flues: they retard the onward flow of the vapours, cause them to circulate to some extent in each part so divided off, and favour deposition. The interposition of wider and larger spaces, such as deposit towers or deposit chambers, through which the vapours may pass more slowly than through a comparatively narrow flue, also promotes the mutual reaction of the constituents of the vapours by the retardation they occasion. There are few works that I have seen in which, by the exercise of a little ingenuity, space might not be found for the adoption of this method. It is not at all requisite that the flue should be in one continuous line. It may be made to pass backwards and forwards, either under ground or above ground, with as many bends as may be requisite to obtain the necessary length; indeed, the more it is bent about the better for its efficiency, the draught being duly regulated. Where the mixer is thoroughly closed as at Burnard, Lack, and Alger's works, it is no bad plan to throw the vapour from the mixer into the den, which then becomes a first condensing or deposit chamber. It is impossible to say what should in all cases be the length of the flue. The determination of this must depend upon a variety of considerations, among not the least important of which is its capacity, the presence of condensing or deposit chambers, and the rapidity of the current through the flue. At Vicker's works in Widnes 440 feet are not found too great a length.

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* Dr. Dupré's experiments detailed in the Appendix to this Report fully confirm my inferences both with respect to the value of a long flue and of a water condenser or scrubber.

Neither is there any doubt in my mind that, when a great length of flue is considered unattainable or would be inconvenient to construct, a sufficient protection against nuisance from the vapours proceeding from the process of mixing may be found in a well-considered and well-arranged water condenser or scrubber. My experience of the condenser at Mr. Newton's works in South Bermondsey and of that in use at Burnard, Lack, and Alger's at Plymouth, has quite convinced me of this. Where there is a very abundant and unlimited supply of water, Newton's condenser is applicable, but where the supply is not so abundant, as, for example, where it is taken from a town supply, and has to be paid for by meter, Burnard, Lack, and Alger's condenser is much more economical and equally effective. In my visits to manure works I have frequently seen water condensers or scrubbers upon the premises, which in reality were little better than playthings, and quite useless for their supposed purpose. The principal faults with them have been that water has been used stingily, that they have been badly packed with coke or some other material that has become quite choked up with deposit, or that they have been allowed to become dilapidated from neglect and practically useless —even if a pretence of using them was made. When water is supplied by a rose the perforations after a time become rusted up or choked with silica, and the same thing often happens with the perforations of a colander above the condensing chamber, so that when I have had the water turned on I have seen only a few jets falling, where provision was supposed to be made for an abundant shower. In other works I have seen various fanciful devices for sprinkling water into the condensing chamber, the only possible use of which was to save expense while making a pretence of condensation. All such devices have been mere shams. The provision of a water condenser on the premises is no evidence that it is used, as was strikingly illustrated during a visit I paid to the Western Counties Manure Works at Tor Point.

The ordinary faults of condensers.

It has appeared to me that when economy of space is a consideration, advantage might be gained by carrying the vapours into a sufficiently large chamber filled with spray produced by causing water under considerable pressure to impinge upon a copper disc or upon several discs. I gathered this idea from observing the arrangements for cooling air supplied to the law courts at the Town Hall, Salford. A similar idea appears also to have occurred to the managers of Langdale's Manure Works at Newcastle-on-Tyne, but here it was attempted to spray the interior of a flue bent several turns upon itself and, the space being too narrow, the attempt proved a failure. But the principle is one which, I hope, will yet be carried into effectual operation at these works.

Proctor and Ryland's arrangements.

But I have yet to mention the arrangements adopted at Proctor and Ryland's works in Birmingham, by which the vapours are dealt with as they arrive from a mixer, not worked by machinery but by hand. I have already, p. 254, described the chambers in which the mixing is effected. From the upper part of each chamber a wooden flue, 2 feet square, conducts the vapours a distance of several yards (varying in the case of the two chambers), to a small fan which drives them down a pipe which, at the bottom, dips about a foot into an underground tank of cold water, renewed from time to time. In this tank the solid matters (dirt and silica) are deposited. It also receives, as I have pointed out (p. 229), the waste steam from the boilers, &c., and the overflow runs into the drains. From this chamber the vapours, or so much of them as remain uncondensed, are conducted into a fire. The arrangement is figured in Plate 16. I can say nothing as to its efficiency—mixing was not proceeding on the day that I visited the works.

4. From removal of manure from hot den.

4. The nuisance arising from the removal of the manure from the den is one of the chief of those now proceeding from manure works. But it is, at the same time, the nuisance which it is most difficult to find a remedy for. I protest, however, against any assertion that there is no practicable remedy. It is very difficult to find a practicable remedy, but cannot be impossible. To say this would be to ignore general experience in respect of many kinds of offensive businesses, as to which the same thing might have been said formerly, but cannot be said now. The discovery and application of a remedy is only a question of time, experiment, and cost. Only it is essential that the costliness of the remedy should not be excessive. Let us see, then, what is wanted. The nuisance arises from the emission from the hot manure of similar vapours to those which proceed from the mixer during the mixing process. The free space above the hot manure is full of them, and similar vapours are mechanically pent up in the mass of consolidated manure, and come off when the mass is broken up; on the opening of the den they pass at once into the atmosphere through the windows or doors of the den, or first into the building and then through its various openings into the outside atmosphere. In addition to such a prolongation of the mixing in the "mixer" (when practicable) as shall bring about the evolution of the major part of the vapours capable of formation where they can readily be conducted away and dealt with (one method no doubt of reducing the nuisance more or less, according to circumstances), two kinds of remedy may be suggested: either the manure may be left to become cold in the den, and thus the vapours in the den and those mechanically imprisoned in the manure to become so condensed as not to be evolved in any considerable volume on disturbing the manure; or the vapours may be permitted to escape into the building and be drawn off from it, and dealt with in an appropriate manner. These two suggestions must be considered separately.

Suggested remedies.

a. Suggestions for promoting cooling of manure.

a. The former of these suggested methods is the more difficult to carry into effect, for the reason that, although some manures consolidate quickly, all kinds cool slowly; many days, as I have shown above, must elapse (under the most favourable conditions) before the manure becomes cold enough to be removed without emitting a good deal of offensive vapour. If this, then, were insisted on, it would involve great inconvenience and loss to the manufacturers at the busy season of the year, at least under present arrangements. Few works have more than one mixer, and still fewer more than two, and there is usually only one den associated with each mixer, occasionally there are two, but I have rarely seen more than two. Hence with two mixers, each with two dens, one den of the four being filled daily, only two full days could be given for cooling in each den, since on the third day it would have to be emptied for refilling on the fourth, and this would still leave the manure too hot. But there are few works so favourably circumstanced as this. I have had many conversations with large manufacturers as to modes in which this difficulty might be met. Looking at the matter with an unpractical eye it might be said that a remedy might be found in increasing to the necessary amount the number of dens and mixers. Of course this would be a remedy, but it would involve the devotion of very much more space than can be spared, even in the largest works, where room is wanted for storage, both of materials and also of made manures, which (although it may be made all the year round to meet the requirements of a large trade) is for the most part only sold off at one period of the year. This, then, is an impracticable remedy. Again, it may be said that, instead of having only two dens associated with each mixer, there might be, say, four, the mixer being so placed as that the manure shall be discharged into each in succession ; but to this the same objection as to the space requisite for such an arrangement might be made. Another mode of meeting the difficulty would be the adoption of means to expedite the cooling of the manure. One mode of doing this suggested itself to my mind on observing that at some works a very large area was provided for the floor of the den, and that it was only filled to the height (nearly uniformly) of about four feet; while in other works, where the area was small, the manure lay upon it to the height of 10 or 12 feet. A quantity of manure lying only 4 feet in depth cools far more rapidly than a quantity lying 10 or 12 feet in depth. When suggesting this to Mr. Burnard he said that, while the remedy would be very applicable to some kinds of manures it would not be applicable to others, since it presupposed that all manures would flow with equal readiness when discharged fresh into the den, and would set with equal rapidity, and this is not the case. Besides, he pointed out that the action of the acid continues after the discharge of the manure into the den and that in many cases it is desired that it should continue; but to enable the action of the acid to continue, the temperature must be maintained, and the manure must not be allowed to become prematurely chilled as it would be, especially at a distance from the place of entrance, if allowed to spread itself out in a thin layer. Probably this last objection does not apply to all kinds of manure, but it does to some. Mr. Burnard has since written to me thus : " When working with materials containing much " iron, I am informed by Mr. Packard, who has had much experience in " working German phosphorites, that the den should be so constructed " as to allow the manure to run out thin, so as to cool very quickly. This " method of working them prevents, or rather lessens to a considerable " extent, the combination of the iron, lime, and phosphoric acid, so " that the superphosphate does not go back in its per-centage of soluble " matter." Mr. Burnard adds, " In working with Cambridge and some " other coprolites whose 'setting' power is good, depth is not essential; " but in our experience, with the materials we have been accustomed " to use, we find depth essential ; in fact, the nearer we can come to a " cube, less the corners, the better. When the liquid manure has to " flow far, the thinner parts (containing excess of acid) run off from " the thicker and undissolved parts, so that the mass is not uniform. " This separation is especially likely to take place and to be inconvenient when bones are used, since they mostly remain under the shoot, " whereas they ought to be distributed equably so as to give them a "fair chance of softening and becoming incipiently dissolved." In estimating the value of these observations of Mr. Burnard, it is to be kept in mind that he regards the "mixer" merely as a mixer, as merely the place where the action is initiated; and looks to the den as doing the greater part of the work. The objection to the manure being allowed to form a thin layer would apparently be less in works where (similar materials being used) the mixing in the "mixer" is prolonged to pastiness. My conversation with Mr. Burnard then turned upon the practicability of drawing off the vapours from the den prior to and during the whole process of removal, and he told me that he was himself about to try to effect this, and showed me an apparatus (Körting's blower) which he was about to put up with the view of driving all these vapours through his condenser instead of allowing them to issue into the building. He has since informed me that the attempt has at present issued in failure, but that he intends to try again.

b. Drawing off of liberated vapours.

b. The latter of the suggested methods of meeting the hot den difficulty, namely, permitting the vapours to escape freely into the building, and then drawing them off, is not only practicable, but may be seen in operation at Hunt's works at Bow Bridge. I have twice already referred to these works, and the successful manner in which the manure and bone boiling nuisances have been grappled with (pp. 227 and 270). At these works all the vapours from the mixer, and from the whole interior of the buildings, which are virtually close buildings, are drawn off through appropriate flues by means of a powerful fan, which drives them first through a washer, and then through a fire. Nothing offensive escapes externally. If it should be argued that some manure buildings are too extensive to be thus dealt with, the reply is that it is quite practicable to partition off the largest building into chambers, each of which might if necessary be separately dealt with. Of course such a practice as that which I have described (p. 263) as followed at Norrington's works at Plymouth, should not, in the vicinity of a town, be tolerated for a day.

5. From general offensive odour from works.

5. The general offensive smell from manure works, which is not immediately dependent upon the processes of mixing and removal of the hot manure, may be similarly obviated by ventilating all parts of the interior of the building where manure is stored or manipulated into a tall chimney shaft by means of a fan. Advantage would also be gained by the periodical renewal of the inner surfaces of the building by means of a layer of lime wash, and by the observance of cleanliness generally. I am satisfied that manure making might, with a little extra trouble, be carried on in a much more cleanly and less slovenly manner than is observable in most of the works I have visited. The drying of scutch manure by spontaneous heating should be carried on only with the precautions suggested for similar spontaneous drying of boiled bones (p. 229). Kiln drying, or drying upon flues, should not be carried on upon open kilns. The kilns should be situated in a building of some sort, from which the vapours should be drawn off and conducted through a fire. No great ingenuity need be exercised in effecting this.

Avoidance of nuisances in poudrette making.

The means adopted at Bilston by the Towns Manure Company for preventing nuisances during the manufacture of poudrette from night-soil were, at the time when I visited the works, as follows:—The whole of the process, from the reception of the night-soil in covered vessels to the packing of the poudrette in bags, was conducted within a closed building. The night-soil, immediately the sulphuric acid was added to it, was emptied into one of Milburn's patent desiccators (30th July 1872, No. 2,266). The interior of the machine communicated with a Baker's blower, which sufficed to create a sufficient in-draught to prevent any escape of offensive effluvia through the crevices of the cover, or when the cover was partially removed for the purpose of charging the machine. By means of a special arrangement of flues, this blower drove the vapours given off through two fires used for heating the drying floor, and the products were discharged from a chimney shaft 128 feet in height. As the furnaces were arranged at these works, an occasional escape of unconsumed vapour might take place if the stoker was not very careful in the manner of coaling, and in the management of the dampers. But on the whole the plan adopted was successful in preventing nuisance. I have not had an opportunity of seeing the method of drying excrement adopted by Captain Liernur at Dortrecht, but it has been very carefully elaborated, and is said to be unproductive of nuisance.

June 1877. EDWARD BALLARD.

APPENDIX.

PRELIMINARY REPORT on the GASES EVOLVED during the MANUFACTURE of SUPERPHOSPHATE from CAROLINA PHOSPHATE at the Works of JAMES GIBBS & Co., Victoria Docks.

THE superphosphate is prepared by the action of slightly diluted sulphuric acid on finely powdered Carolina phosphate. The mixing of these two is effected in a covered mixer, having a long narrow aperture at the top, through which the powdered phosphate is introduced. This tank communicates with a long wooden flue or shoot, at the farther end of which a fan is worked, drawing a strong current of air through the tank into the shoot and forcing it through a scrubber into a chimney. All gases and vapours evolved during the mixing are thus swept into the shoot, and can only escape into the chimney after having passed the scrubber. About 5,000 cubic feet of air are thus passed through the mixer and flues per minute. The phosphate and the acid are introduced into the mixer in quantities of 12 cwt. of the former to 8 cwt. of the latter, with the addition of about 3 cwt. of water. The thorough mixing is effected by means of a mechanical stirrer, which also helps in emptying the tank, and takes a few minutes only. During the mixing the temperature is greatly raised; but while actually in the tank a small portion only even of the carbonic acid escapes, as the mixture has to be run off into a large "den" beneath before much effervescence takes place, otherwise the mixture overflows from the tank. No doubt the greater portion of the carbonic acid, as well as of the tetrafluoride of silicon liberated, escapes gradually while the mixture is in this "den."

I endeavoured to examine the gases evolved by passing pipes into the shoot,—

1st. As near as possible to the mixer (point I.);

2nd. Into the shoot just before it enters the scrubber (point II.);

3rd. After having passed the scrubber (point III.);

and by drawing the gases from these points by means of small steam exhausts through gutta-percha bottles containing a solution of pure caustic soda, which would absorb the gases sought for, and could afterwards be examined for them. No definite result was, however, arrived at, not only on account of the enormous quantity of air passing through the shoot greatly diluting the gases, but also on account of the silica separated from the tetrafluoride stopping up the pipes of the apparatus. For these reasons I have been unable to come to any definite conclusion as to the existence or non-existence of free hydrofluoric acid in the gases evolved, and must reserve the final decision on this point for a future occasion. The following points, however, have been proved:—

1st. That the gases, after having passed the scrubber, contain no appreciable traces of any fluorine compound, but still contain minute traces of arsenic.

2nd. That the proportion of fluorine compounds evolved is only a small fraction of the amount of carbonic acid liberated (which in the mean of two experiments amounts to about 2 °/o of the volume of air passing through the shoot), probably less than 1/30 part. [The alkali through which the gases from point I. had been passed contained 96 °/o of carbonate of sodium, the remainder consisting of fluoride of sodium, silica, chloride of sodium, traces of arsenic, &c., &c. The solution from point II. contained 98 °/o of carbonate of sodium; that from point III. upwards of 99 °/o.]

3rd. That the gases evolved contain small but distinct traces of arsenic; much of this, however, is stopped by the scrubber.

There are, however, some facts observed which render it at least highly probable that no free hydrofluoric acid is present in the gases evolved.

a. The phosphate employed contains a very large excess of silica compared to the amount of fluorine present, and it is not likely that hydrofluoric acid would be evolved under such circumstances. Two samples of Carolina phosphate used at the works of Messrs. James Gibbs & Co. were found to contain:—

	Sample 1.	Sample 2.*
Carbonic acid - - - -	4·32	4·28
Fluorine - - - -	1·81	1·90
Silica - - - - -	——	12·00

Much of this fluorine, moreover, remains in the resultant super-phosphate, and the ratio between the amount of silica present and fluorine evolved is even much greater than these analyses indicate. Thus the manure made during my visit from sample 2 was found on subsequent examination to contain—

Fluorine - - - - -	0·86 °/o
Silica - - - - -	6·65 °/o

And as one part of phosphate yields about 1·75 part of superphosphate, it follows that the proportions of fluorine and silica left in 100 parts of original phosphate amount to—

Fluorine - - - - -	1·50 °/o
Silica - - - - -	11·64 °/o

showing at all events that by far the greater proportion of fluorine is left in the superphosphate. The same seems to be the case with regard to the arsenic contained in the sulphuric acid used, the greater part of which remains in the superphosphate under circumstances similar to those of these works.

b. It is highly improbable that in a mixture of tetrafluoride of silicon, hydrofluoric acid and steam, silica would be deposited as long as any hydrofluoric acid is present. The deposition of silica therefore shows, I think, that at that point no hydrofluoric acid is present. Now, the deposition of silica begins at once, or almost at once; and as, owing no doubt to an insufficiency of watery vapour and the comparative shortness of the flue at these works, only a small proportion of the total amount of tetrafluoride evolved is decomposed in the shoot, the far greater part reaching the scrubber to be there decomposed, the amount of hydrofluoric acid contained in the gases evolved can be but a small fraction of that of the tetrafluoride, otherwise no deposition of silica would take place at the near end of the shoot.

During the passage of the gases and steam along the shoot a variety of reactions probably take place. A portion of the fluosilicic acid produced is again evaporated, and thereby split up into tetrafluoride and hydrofluoric acid; this in turn acts on the silica separated, once more forming tetrafluoride to be again decomposed, &c., &c. It is thus possible that traces of hydrofluoric acid may be found in parts of the shoot; and the etching effect on glass which the gases evolved produce, is no doubt mainly due to this evaporation and consequent decomposition of hydrofluosilicic acid.

As the case stands, we are thus, I believe, justified in concluding—

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* This sample was taken from the material used during my visit to the works.

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1st. That by far the greater portion, if not all, of the fluorine evolved during the process of manufacture of superphosphate from Carolina phosphate, is evolved in the form of tetrafluoride. If no efficient scrubber is used this tetrafluoride would escape into the air and be converted gradually into fluosilicic acid and silica. The fluosilicic acid in its turn may, wherever it is condensed and again evaporated, produce free hydrofluoric acid. If, however, an efficient scrubber is employed, the whole of the fluorine compounds are arrested.

2nd. The gases evolved when certain kinds of sulphuric acid are used contain distinct traces of arsenic, not all of which is arrested by the scrubber, but escapes in part into the air.

3rd. The superphosphate produced contains the greater part of the fluorine present in the phosphate employed, as well as the greater part of the arsenic contained in the sulphuric acid used.

(Signed) A. Dupré,

Westminster Hospital,
June 30th, 1877.

Further Report on the Gases Given Off in the Manufacture of Superphosphate from Carolina Phosphate, at the Works of Messrs. James Gibbs & Co.

In a previous report, dated June 30th, 1877, the method of manufacture adopted at these works, as well as the general character of the gases evolved during manufacture, was described. It was there shown that, in all probability, all the fluorine evolved during the process was given off as tetrafluoride of silicon. The apparatus then employed in the collection of the gases did not, however, enable me to settle the question definitely, and I have therefore again visited the works with a more efficient form of apparatus, with which I have obtained much more definite results. Before describing these, the following additional details connected with the manufacture may be mentioned.

As before explained, the powdered phosphate, sulphuric acid, and water, are introduced into a mixer in the proportions of 12 cwt., 8 cwt., and 3 cwt. respectively. They are thoroughly mixed by a mechanical stirrer, and run into a den, before any considerable evolution of gas has taken place. During this mixing the temperature of the mass rises considerably, up to 160 or even 186° F., according to the length of time it is kept in the mixer. Usually the temperature in the mixer ranges between 120 and 160° F. only, but goes on rising somewhat in the den, in which the temperature of the mass, when about 30 tons had been run in, was found to be 180° F. The temperature in the shoot, close to mixer and den, both of which are ventilated into the shoot, stood at 80° F. shortly after the mixing had begun, but as more and more of the hot mixture accumulated in the den the temperature gradually rose to 125° F.

The air in the shoot was found to be perfectly saturated with moisture, even at the elevated temperature, and there can therefore be no question that much more than sufficient water is present to decompose all the tetrafluoride that could possibly be contained in the gases evolved. But to return to the experiments.

A lead pipe ($\frac{5}{8}$in. diam.) was passed into the shoot close to the entrance of the flues from the mixer and den. Through this pipe a portion of the gases, &c., &c., passing through the shoot was drawn by means of a small steam exhaust, and forced, together with this steam, into a lead condenser kept cold by water. In this condenser the steam from the jet, as well as that present in the air, is condensed, and any tetrafluoride of silicon present is decomposed into silica and fluosilicic acid, the latter dissolving in the condensed water. Any hydrofluoric acid present would simply be dissolved. In case no hydrofluoric acid is present the condensed liquid would contain silicon and fluorine in the proportion of 1 equivalent or

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28 parts of the former, to 6 equivalents or 114 parts of the latter. If, however, hydrofluoric acid as well is present in the gases the proportion of fluorine would be found higher. The acid liquid as it ran from the condenser was at once filtered, to prevent, as far as possible, all action between the silica separated and any hydrofluoric acid that might be present. The liquid was also collected in two portions, the first portions between the hours of 1 p.m. and 2.30 p.m. (the mixing having begun at 1), the second between 2.30 and 4 p.m. While the pipe between shoot and condenser was clear (occasionally it had to be cleared) about 50 cubic feet of air passed through the condenser per minute, which, though only a small portion of the amount of air passing through the shoot (about 5,000 cubic feet per minute), was yet sufficient to yield an amount of acid readily allowing the quantitative estimation of the fluorine and silica contained in it. These were found to be the following:—

	Silicon.	Fluorine.
In the first portion - -	0·081 °/o	0·32 °/o
In the second portion - -	0·091 °/o	0·35 °/o

The proportion of silicon found is thus a little higher than it should be on the assumption that all the fluorine is present as fluosilicic acid when it should have been 0·079 °/o and 0·086 °/o respectively. The small excess found is no doubt due to the fact that the freshly separated silica is slightly soluble in the condensed liquid. It is thus clear that all the fluorine contained in the gases evolved is present in the form of tetrafluoride, and no portion of it in the form of hydrofluoric acid.

When the mixing begins the temperature of the shoot is comparatively low, and much moisture, containing hydrofluosilicic acid in solution, will be condensed even in the first portions of the shoot. As the temperature rises some of this will again be volatilized; but as this volatilization takes place in contact with a large excess of finely-divided silica (deposited in the shoot) tetrafluoride of silicon only will be produced. This in its turn is again decomposed, in the cooler parts of the shoot, into silica and fluosilicic acid. If then the shoot is of sufficient length to allow the gases to become cool, all the tetrafluoride will be completely decomposed into silica, which is deposited in the shoot, and into fluosilicic acid which remains dissolved in the water condensed, and no irritating gases will escape into the air. In case the shoot is short it will have to be supplemented (as it is in the works of Messrs. Gibbs & Co.) by an efficient scrubber. Taking then this and the former investigation together we arrive at the following conclusions:—

1st. All the fluorine evolved during the process of manufacture of superphosphate from Carolina phosphate is evolved in the form of tetrafluoride.

2nd. By the employment of a sufficiently long shoot, or a short shoot and a scrubber, all the tetrafluoride can be arrested.

3rd. The gases evolved, when certain kinds of sulphuric acid are used, contain distinct traces of arsenical compounds, not all of which are arrested by the scrubber,

4th. The superphosphate produced contains the greater part of the fluorine that was present in the phosphate employed, as well as the greater portion of the arsenic contained in the sulphuric acid used.

(Signed) A. Dupré.

Westminster Hospital,
Sept. 25th, 1877.

No. 7.

Memorandum by Mr. Netten Radcliffe on the Progress of Levantine Plague in 1875–76, and part of 1877.

I.

App. No. 7.

On Levantine Plague, by Mr. Netten Radcliffe.

Recapitulatory.

This Memorandum relates to the progress of Levantine plague in 1875–76, and part of 1877. In a Memorandum which I prepared last year, and which is printed in the Appendix to the last report of the Medical Officer (New Series, No. VII.), I described the several re-appearances of plague which had occurred since the apparent extinction of the malady in 1844. These, as it will be useful to recall here, were eight in number, namely, (1) the re-appearance in Western Arabia in 1853; (2) in the province of Bengazi, Tripoli, 1858–59; (3) in the extreme north-west of Persia (district of Maku, Persian Kurdistan), 1863; (4) among the Arabs inhabiting the Hindieh marshes, on the right bank of the Lower Euphrates, in 1867; (5) in the tract of country lying to the south of Lake Urumiah, Persian Kurdistan, 1871; (6) in the province of Bengazi (Tripoli) again; (7) in Western Arabia, also again; and (8) among the Affij Arabs occupying the great marsh on the left bank of the Lower Euphrates, north and east of Diwanieh, in 1873–74.

Plague in Mesopotamia. The Lower Euphrates 1873-74.

The appearance of plague on the Lower Euphrates in 1873 was the beginning of an outbreak of the disease which, extending its area of prevalence from year to year, has probably not yet come to an end, and which in the course of the past year (1876) involved a part of South-western Persia as well as Mesopotamia.

Briefly to recapitulate the facts of the beginning and development of this outbreak, I may mention that the disease was earliest observed towards the close of 1873 among the Affij Arabs, who inhabit the first of the series of great marshes which exist on the east bank of the Euphrates below Hillah. It prevailed chiefly among the Affij villages, but extended to both banks of the river, attacking Diwanieh, and spreading among the villages lying between that town and Hillah. Several cases occurred in Hillah, and the two sacred towns of Kerbella and Nedjef, on the borders of the Syrian desert, came within the limits of the infection; Nedjef suffering from it to a greater extent than Kerbella. Dr. Castaldi, the Ottoman Sanitary Delegate in Persia (who investigated the outbreak in 1874 for the Ottoman General Board of Health) estimated the mortality from plague in the infected district during the last three months of its prevalence that year, namely, April, May, and June, at 4,000. With the accession of the hot season in June the disease (as would appear to be customary with plague in Mesopotamia, when it is prevalent there) rapidly declined and apparently died out, to re-appear at the beginning of winter.

1874-75.

In December 1874 plague again broke out in Diwanieh, and the disease subsequently showed itself in several localities on the Euphrates south of that town. As the year 1875 advanced, the malady spread throughout the district occupied by the Montefik Arabs, which lies immediately south of that occupied by the Affij Arabs, the chief seat of the outbreak the previous year, and extended as low down on the Euphrates as Suk-e-Sheyukh. This year (1875) plague spread over the whole tract of country lying between the Shat-el-Hai eastwards and the Euphrates from Samava to Nassreah, the Shat-el-Akshan, and the Sea of Nedjef westwards, attacking Kut-el-Amarah at the junction of the Shat-el-Hai with the Tigris, Shinafieh at the outlet of the sea of Nedjef, and Nassreah at the junction of the lower communication of the

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Shat-el-Hai with the Euphrates. Moreover, spreading lower along the river than Nassreah, the disease as already mentioned appeared in Suk-e-Sheyukh. On the setting in of the hot season of 1875, as in 1874, plague again declined and seemingly ceased. No official returns of the loss of life in this year's prevalence have yet been published. Surgeon-Major Colvill, attached to the British Residency, Bagdad, who visited the infected district while the epidemic was in progress, estimates the probable mortality from plague for the two years 1874 and 1875 at 4,000.[*] He apparently considers the official returns of the mortality in 1874, upon which Dr. Castaldi based his estimate of the mortality for the three months of greatest prevalence of plague that year, as much exaggerated. If Mr. Colvill's estimate be the more trustworthy, the development which the epidemic underwent in 1876 assumes a more serious aspect from the large proportions which must be assigned to it. The cessation of plague in Mesopotamia, during the hot season of 1875, was announced by a telegram from Bagdad, dated the 11th July.

1875-76.

I now enter upon the history of the further development of plague in Mesopotamia in 1876.

In the middle of November 1875 plague again broke out on the Lower Euphrates. It first showed itself within the district on the left bank of the river, in the two permanent marsh villages of Obara and Abu Jassein, appearing in each village about the same time. Obara lies 10 miles, or thereabout, to the north-north-east of Hillah, and of its inhabitants, forming eight families, all were killed by the disease except one, an old woman. Abu Jassein, a village within the district occupied by the Abu Sultan tribe of Arabs, lies south of Hillah, and is situated on a small irrigation canal which opens from the Euphrates between the Abu Chumash[†] and the Dagarra canals. Here, among a population estimated at 400, plague was fatal to 80 persons in the short period of from six to seven days.[‡]

Near upon the same time that plague broke out on the Euphrates, it appeared also on the Tigris, at Azizie, a temporary village of reed huts, situated on the right bank of the river, between Kut-el-Amarah and Amarah.[§] Information as to this outbreak, the first relating to the probable re-appearance of plague in 1875–76, was communicated by the Sanitary Administration of Bagdad to the General Board of Health of Constantinople, in a telegram dated the 6th December 1875. In this telegram the disease was designated as "a bubonic malady;" and although its actual nature was no doubt suspected both in Bagdad and Constantinople, no measures appear to have been taken to ascertain whether it was an isolated phenomenon or not. It was not, indeed (as would seem from the information furnished to this Department), until late in February that further information was communicated from Bagdad to Constantinople on the subject of plague. On the 20th of that month a telegram from the former city announced that from six to eight deaths from plague were occurring daily in Hillah. At this date plague had been present in Hillah certainly since the 1st January, on which day a death from the disease was officially recorded, and it had existed in the surrounding district since the middle of the previous November. It was probably present also in February at Kut-el-Amarah on the Tigris, although its existence there at this time was not ascertained until the beginning of May by Mr. Colvill. It was, moreover, most probably distributed at the same period, as subsequent events showed, over the greater portion of the area afterwards occupied by the malady this year (1876) in Mesopotamia, not even excepting Bagdad itself, where its presence appears to have been first made known officially on the 1st March. 1876.

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[*] See Mr. Colvill's Report on Plague in Mesopotamia in 1874–75, printed with my previous Memorandum.

[†] The Abu Chumash canal appears to be the first in order of the larger irrigation canals opening from the left bank of the Euphrates, above the Dagarra canal.

[‡] These facts were ascertained by Surgeon-Major Colvill during a personal inspection of the district, made in the last week of February 1876.

[§] Amarah is situated about midway between Kut-el-Amarah and Kurna, on the left bank of the Tigris. In the despatch conveying the news of this outbreak to England, as quoted in my first Memorandum, Azizie was described as situated "near It' Hané," on the Euphrates. The information as to the position and character of the village given in the text, also as to the position of Amarah, was derived from Mr. Colvill during his recent visit to England. Dr. Castaldi, the Ottoman Sanitary Delegate in Teheran, in a communication to Her Majesty's representative at the Shah's Court, gives the following account of the outbreak at Azizie, upon the authority of a journal published at Bagdad, in the Turkish language, and having the title of *Le Zebre*: "Towards the epoch of the feast of Kourban Bairam, in the Kaimacanate of
" Azizie, nine individuals, camped under tents and belonging to a nomad tribe, having
" eaten of the flesh of a diseased camel, became suddenly ill. They were attacked
" with ardent fever and had buboes in the groins, the armpits, and behind the ears.
" Of these nine individuals eight died, one alone recovering. According to the same
" journal two medical men were sent to the spot, and caused it to be isolated by a
" sanitary cordon. No extension of the malady elsewhere, it is stated, followed. But
" it would appear from a letter, dated the 3rd February (1876), which I have received
" from M. Paduan, the Sanitary Inspector for Bagdad, that a few days after the
" adoption of the measures authorised by the Kaimacan of Azizie, another case

Except in a few instances, chiefly relating to the larger centres of population, chronological data as to the extension of the disease in Mesopotamia in 1876 are not forthcoming; but the area within which it prevailed and the district chiefly affected by it would seem to have been ascertained with reasonable probability. The malady would appear to have shown itself with more or less activity in various parts of the tract of country lying between the Shat-el-Atchin and the Shat-el-Hai, and along that part of the course of the Euphrates where it had been chiefly active the previous year (1875). Thus its presence was noted again at Shinafieh, on the Sea of Nedjef, at Jerboyah, Diwanieh, Samara, and other places on the Euphrates as low down as Suk-e-Sheyukh, and along the course of the Shat-el-Hai to its junction with the Tigris at Kut-el-Amarah. Moreover, in the district lying to the north of the tract of country above described, and which had been the scene of the outbreak of 1873–74, plague was noted at Meshed Ali, at Kufa, Kifl, Tanabi (Tuarich) on the borders of the Hindieh marshes (the last-named place being the chief town of the Hindieh district), and at Kerbella. The disease also appeared at Hillah and at Bagdad, and in the villages of the district lying between the two towns.

The stress of the outbreak of 1875–76 would appear to have fallen upon the tract of country which extends immediately to the north of the district that had suffered in 1873–74. This tract includes the two chief Mesopotamian towns (Bagdad and Hillah), and came now with them for the first time, since the re-appearance of the disease on the Lower Euphrates in 1873, fully within the area of its active prevalence.

Hillah, 1876. During the first week of 1876, 14 deaths from plague were recorded in Hillah, the earliest of these on the first day of January. From this period until the cessation of the disease in June plague was probably never absent from the town. The official records (which in this

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" occurred under the tents of the same tribe. M. Paduan adds that he entertains " serious fears that this malady, which he has no doubt is plague, will compromise " Bagdad, by reason of the contiguity of the infected locality (15 hours distant from " the city) and the insubordination of the tribe among which the disease has broken " out."

instance and in all other instances where reference will have to be made to them in this Memorandum, include only the cases and deaths declared to or discovered by the local authorities, and probably comprise little more than half the actual number) show an aggregate mortality from plague of 1,007 from the 1st January to the 22nd June, inclusive. Below is a summary of these records so far as they have been furnished to the Department.* They indicate that the disease gradually increased in activity from the close of February until April, during which month it appears to have been most widely prevalent in the town; that it declined, at first slowly and afterwards more rapidly, in May; and that, finally, it ceased in July. The malady first showed itself and became prevalent in the portion of Hillah which lies on the left bank of the Euphrates (on which bank, in the district adjacent to the town, the disease had broken out in November 1875); and it was not until the beginning of the third week of March that its existence in the portion of the town on the right bank of the river was officially notified. But at the beginning of March, as was ascertained by Mr. Colvill, plague had appeared in several of the villages of the district on the right bank adjoining Hillah, and deaths from the disease had occurred on the routes from that town to Kerbella and Nedjef, among persons engaged in carrying to those places corpses for burial, the population of Hillah consisting mainly of Shiah Mahommedans.

The village of Kifl, lying on the eastern margin of the Hindich marshes, and the place where persons journeying to Nedjef take boat to navigate the marshes, was attacked with plague at the beginning of March, or at the close of February. Writing on the 6th April, Mr. Colvill reported that, "during a few days before the 7th March," 15 persons had been attacked, and 14 had died from the disease in this place.

Plague was first noted in both Kerbella and Nedjef in the course of March. If such official records of the disease in these towns as have come to hand could be trusted, scattered cases only would appear to have occurred in the first-named town, while in the last-named town it spread to a certain extent. Seven deaths from plague were reported from Kerbella during the three months of March, April, and May; and 98 deaths from Nedjef from the 25th March to the 28th May, inclusive. Dr. C. Millingen, however, one of the delegates of the Ottoman General Board of Health to the Medical Commission in Bagdad, estimates the

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* SUMMARY of Official Statements made to the Foreign Office respecting the progress, in 1876, of Plague at HILLAH (Estimated population 15,000).

1876.	Cases.	Deaths.
Jan. 1–7 - -	—	14
„ 8–14 - -	—	6
„ 15–20 - -	—	14
„ 21–27 - -	—	17
„ 28–Feb. 4 -	—	7
Feb. 5–11 - -	—	0
„ 12–18 - -	—	0
„ 19–21 - -	—	3
„ 22– - - Mar. –12 - -	108	43
„ 13–19 - -	45	25
„ 20–26 - -	76	34
„ 27–Apr. 1 -	66	42
Apr. 2–7 - -	112	56
„ 8–14 - -	166	86
„ 15–21 - -	230	159
„ 22–28 - -	245	148
Apr. 29–May 5 -	84	48
May 6–12 - -	152	121
„ 13–19 - -	68	111
„ 20–26 - -	46	36
„ 27-31 - -	16	11
June 1– 3 - -	0	0
„ 4–10 -	17	10
„ 11–17 - -	9	
„ 18–24 - -	7	3
„ 25–July 2 -	2	2
July 6–13 - -	5	3
„ 17-22 - -	4	4
„ 28 - - -	1	0
„ 30 - -	1	0
Total Deaths -		1,007

mortality from plague in Kerbella in 1876 at about 100, and in Nedjef at 250.

Kut-el-Amarah, on the Tigris, below Bagdad, was attacked by plague most probably early in February. Out of a population of about 1,500, there were in this village, according to Mr. Colvill, 330 to 340 attacks, of which not less than 300 were fatal.

Bagdad, 1876.

In the course of the second week of March the presence of plague in Bagdad was officially recognised. Five cases and two deaths from the disease were recorded as having occurred in the portion of the city lying on the right bank of the Tigris on and before the 13th March. The disease quickly increased, and became most prevalent during the later weeks of April and the earlier weeks of May. It declined rapidly in June, and ceased in July. From the 13th March to the 5th July, inclusive, 4,570 cases and 2,616 deaths were reported to the local authority.*

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* SUMMARY of Official Statements made to the Foreign Office respecting the Progress, in 1876, of PLAGUE in BAGDAD (Estimated population 60,000).

1876.	Plague. Cases.	Plague. Deaths.	Deaths from Other Causes.
To 13th March	5	2	—
March 16—20	29	15	—
„ 21—27	119	45	43
„ 28—April 1	145	75	38
April 2—8*	256	169	31
„ 9—15†	455	267	53
„ 16—23	535	336	46
„ 23—29	609	399	32
„ 30—May 6	643	409	28
May 7—13	480	341	31
„ 14—20	457	234	25
„ 21—27	304	162	35
„ 28—June 3	311	76	31
June 4—10	132	69	28
„ 11—17‡	79	12	—
„ 18—24§	7	3	—
„ 25—July 2	4	2	30
	4,570	2,616	

* Plague appeared in the barracks and prisons.
† Twenty cases of plague and 8 deaths among garrison, and 7 deaths among prisoners.
‡ Ague and pernicious fevers began to increase in frequency.
§ Noon temperature ranged from 33° to 42° Cent. (91·4° to 107° Fahr.) this week.

The above Table is compiled from the official returns furnished to the Department during the progress of the outbreak. On the 23rd June, the British Resident in Bagdad, Col. Nixon, communicated by telegraph the following summary return of deaths from plague during the outbreak.

BAGDAD, 1876.

	Deaths from Plague.
February and March	259
April	1,707
May	1,550
June	123
	3,639

This is no doubt the more accurate return.

The first cases seen by Mr. Colvill in Bagdad were discovered by him in the portion of the city on the left bank of the river, during a search made on the 30th March, in consequence of a rumour having reached him that plague was suspected to exist there. He found 12 cases of the disease in the quarter of the city known as "Bab-il-Shaek" from its surrounding the great tomb of "Shaek Abdul Kadr," and ascertained that six deaths had occurred from it there, three of them during the previous night. Mr. Colvill states that it was in this spot that plague first showed itself in the outbreak of 1831.

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On Levantine Plague, by Mr. Netten Radcliffe.

On the 11th April the river Tigris rose to an unaccustomed height, and the next day it burst its banks in several places above the city, inundating the environs.

In April plague broke out in Khuzistan, South-western Persia, apparently having extended there from the infected district in Mesopotamia. Of this outbreak an account will be given in a later section of this Memorandum. It is here mentioned in its chronological sequence.

The next month (May), near the beginning, information appears to have been first received, by the Sanitary Administration in Bagdad, of the presence of plague at several points on the Euphrates below Hillah, including Diwanieh, Samava, and Suk-e-Sheyukh, at Shinafieh on the Sea of Nedjef, and along the course of the Shat-el-Hai.

Above Hillah, on the Euphrates, at a date unknown, Musseib, the place where caravans coming from eastwards, and travelling to Kerbella, cross the river, was attacked.

Dr. C. Millingen has given the following estimate of the mortality probably occasioned by plague in the outbreak of 1875–76.

	Approximate Number of Deaths from Plague.
Hillah and its neighbourhood - - - -	6,000
Kufa - - - - -	70
Kifl - - - - -	250
Musseib - - - -	80
Kerbella - - - - -	100
Nedjef - - - -	250
Hirdijih (? Hindieh) villages - - -	2,500
[Bagdad - - - -	2,616]
Minimum mortality from plague throughout the province, including the nomadic tribes -	20,000

On the 22nd June, after unconfirmed rumours of the existence of plague at Kerkook and Mosul, the General Board of Health, Constantinople, received by telegram from its sanitary agent in Teheran a notification of the reported prevalence of the disease at Sakkys, in Persian Kurdistan. The district of Sakkys had been in part affected by the circumscribed outbreak of plague which had occurred in Persian Kurdistan in 1871, but the town of the name, the seat of the outbreak to which the telegram referred, had then escaped. The Ottoman General Board of Health, on the receipt of Dr. Castaldi's telegram, immediately telegraphed instructions to two of their agents, Dr. Wortabet and Dr. Sebastio, then at Mosul on their way to Bagdad, to proceed to Sakkys and report upon the state of things as to epidemic disease there. These gentlemen visited Sakkys, and failed to discover any trace of plague, but ascertained that small-pox had been epidemic in the district.

Persia, 1876.

The outbreak of plague in Khuzistan, South-western Persia, already referred to, was investigated by Dr. C. Millingen. The following account of the results of this inquiry is taken from a letter addressed by Dr. Millingen to Mr. Colvill, with a copy of which the last-named gentleman has favoured me.

" The disease at Shuster* was certainly plague. The said disease

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* Shuster was the capital of the province of Khuzistan until it was nearly depopulated by plague in 1832. After this catastrophe, Dizful, 30 miles distant, took precedence as chief town of the province.

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“ first appeared in a village 10 miles to the north of Shuster, called
“ Jellikan, towards the latter part of March. It broke out there just
“ after the arrival of a caravan of pilgrims from Kerbella, who had come
“ by way of Hillah, Bagdad, Amarah, and thence by land to said village.
“ Two persons belonging to said caravan died of plague; the corpses
“ were washed and buried at Jellikan. Shortly afterwards cases
“ occurred in the village in such numbers as to constitute an epidemic.
“ Out of a population of 300 souls there were 85 deaths. At Shuster
“ the disease appeared in April. The first cases were noticed among
“ persons who had come to the town from Jellikan. The disease lasted
“ to the end of July. Out of a population of 8,000 there were about
“ 1,800 deaths. As many as 40 deaths a day occurred during the height
“ of the epidemic. In the neighbouring villages there were a few
“ isolated cases. At Shahwelli, 20 miles to the west of Shuster,
“ however, a rather severe epidemic appeared about the end of April.
“ Out of a population numbering 400 souls there were 70 deaths.
“ At Dizful some 20 deaths in all occurred during the month of May,
“ chiefly among persons from Shuster. At Ahwas, Hawiza, Mohamrah,
“ and among the Beni Lam and Ichaab Arabs there was nothing in the
“ shape of plague.

“ The mortality in the Shuster-Dizful district did not exceed 2,500.

“ The plague did not originate in said province of Persia, but was
“ introduced from Turkish Arabia by infected pilgrims.”

1876–77.

To the foregoing account of the progress of plague in 1875–76, I add a brief summary of the information which has been received of the progress of the disease in 1876–77, to the time of the present writing (June).

Mesopotamia, 1876–77.

At the beginning of July, 1876, all known active manifestation of plague in Mesopotamia had ceased, and the disease appears to have remained dormant until about the middle of October. It then broke out on the left bank of the Euphrates at a point higher than the disease had previously been observed along the course of the river, namely, in the district of Abu Graib, 50 miles or thereabout above Musseib, the highest point mentioned in the various reports to which plague had extended in the earlier months of the year.*

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* On the 23rd September, during the Servian war, a telegram was published in the *Times*, dated from Belgrade the day before, and stating that “the plague had “ broken out in the army of Abdul Kerim Pasha, in consequence of which the “ Turkish commander was compelled to change his positions before Alexinatz every “ three days, and to burn the tents and huts occupied by his troops.” This statement was not confirmed, and except, as subsequently rumoured, that typhus had appeared among the Turkish forces, it is not easy to understand its origin.

It is noteworthy of the outbreak in the district of Abu Graib, recorded in the text, as of the outbreak at Azizie in November of the previous year (1875), one of several outbreaks marking the beginning of the diffusion of 1875–76, that it was attributed locally to the consumption of the flesh of diseased camels. Drs. Wortabet, Lubitz, and Sebastio, of the Sanitary Administration of Bagdad, visited Abu Graib in the third week of November, immediately after the news of the outbreak reached Bagdad. They saw there two persons who were suffering from fever and glandular swellings, and who had been ill about a fortnight. The inhabitants of the district stated that a month before a party of Anezi Arabs had encamped in it for the sake of pasturage. The camels of the party became ill and were slaughtered, the flesh, notwithstanding the circumstances under which the animals were killed, being used for food. Of those who ate it, 40 sickened and died. The inhabitants then, alarmed by this fatal outbreak of disease, rose upon the nomads, and compelled them to withdraw into the desert.

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On Levantine Plague, by Mr. Netten Radcliffe. 1877.

On the 15th January of the present year (1877), 10 deaths from reputed plague occurred among an Arab tribe living in the district of Azizie, which, as previously described, is situated below Kut-el-Amarah, south of Bagdad, on the right bank of the Tigris.

On the 17th of the same month (January) two cases of suspected plague happened in Bagdad, one of them fatal, on the 24th; and on the 26th another suspicious case, also fatal, was observed. Doubtful cases occurred from time to time in the city during the month of February and in the beginning of March, but after the middle of the last-named month there was no longer question that plague was prevalent in the city, and steadily extending. The total mortality from plague officially recorded from the 26th January to the 16th June was 1,672, a number less by 939 than during the corresponding period of 1876.*

On the 15th March several fatal cases of suspected plague were reported to have occurred at Samara, situated · 70 miles above Bagdad, on the left bank of the Tigris.

The disease, also, according to Mr. Colvill, was probably present the same month in Hillah, and the subsequent month in Shatra, on the Shat-el-Hai, in Amara, and in Azizie.

Finally, to complete this summary of the progress of plague from its re-appearance on the Euphrates in October last to the latest news received, information of the suspected existence of plague in Resht, near to the south-west coast of the Caspian, was telegraphed from Constantinople on the 24th April 1877, and the actual presence of the disease there was made known by a telegram from Teheran, dated the 28th April. A later telegram from Teheran, addressed to the General Board of Health, Constantinople, by Dr. Castaldi, the Ottoman sanitary agent there, and dated 20th May, states that a medical commissioner (Mirza Mehmet Hassan Khan) sent by the Persian Government to Resht, had seen in that town 14 cases of plague, of which 13 ended fatally.†

In the accompanying maps I have indicated (Map I.) the topographical distribution of plague in Mesopotamia in each of the successive years of its prevalence there since the re-development of the disease in

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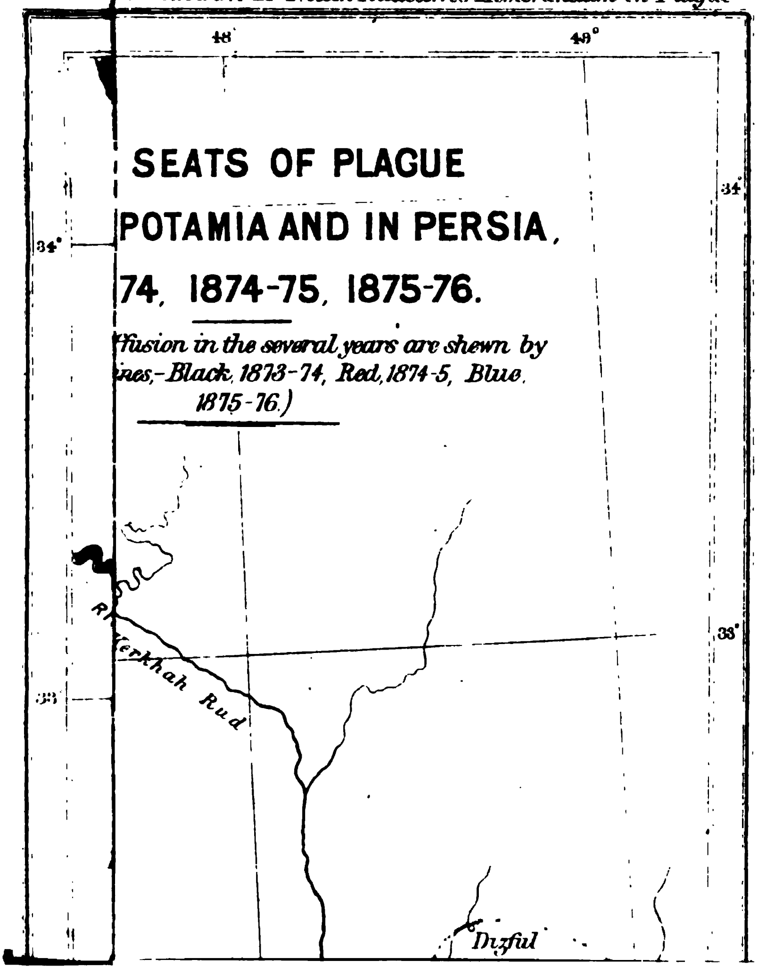
* Table showing the Number of Deaths from Plague officially recorded in Bagdad in 1877 up to June 17th, compared with those recorded for the Corresponding Period of 1876.

1877.	Deaths from Plague.	1876.	Deaths from Plague.
26th Jan. to 31st March	46	To 1st April	137
Week ending 7th April	90	Week ending 8th April	169
„ 14th „	177	„ 15th „	267
„ 21st „	250	„ 22nd „	336
„ 28th „	273	„ 29th „	399
„ 5th May	283	„ 6th May	409
„ 13th „	222	„ 13th „	341
„ 19th „	147	„ 20th „	234
„ 26th „	104	„ 27th „	162
„ 2nd June	24	„ 3rd June	76
„ 9th „	4	„ 10th „	69
„ 16th „	6	„ 17th „	12
	1,672		2,611

† Mr. Consul Churchill, writing from Resht on the 25th April, states that he had caused particular inquiries to be made as to the nature of the disease which had given rise to so much apprehension in that town, from which it had resulted that the malady was not plague. Writing again on the 9th May, he describes the disease as of "a very peculiar nature," and although still questioning its being plague, he states "that it is difficult to say what the malady really is."

To illustrate Mr Netten Radcliffe's Memorandum on Plague



SEATS OF PLAGUE
POTAMIA AND IN PERSIA,
74, 1874-75, 1875-76.

ffusion in the several years are shewn by
ines,-Black, 1873-74, Red, 1874-5, Blue,
1875-76.)

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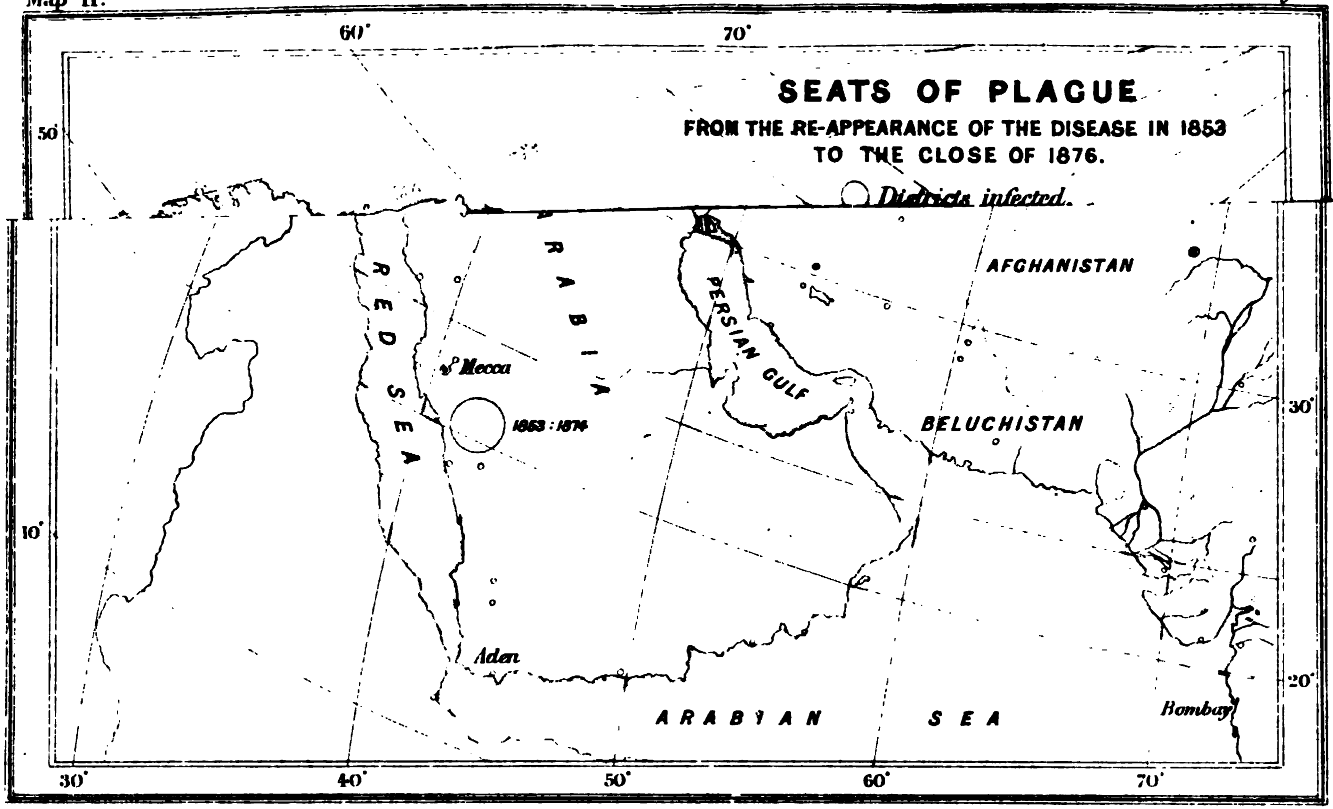
Map II.

To illustrate Mr. Netten Radcliffe's Memorandum on Plague.



SEATS OF PLAGUE

FROM THE RE-APPEARANCE OF THE DISEASE IN 1853
TO THE CLOSE OF 1876.

○ Districts infected.

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TILDEN FOUNDATIONS.

1873; and (Map II.) the geographical distribution of the several outbreaks of the malady since its re-appearance in 1853.

II.

MEASURES OF PREVENTION ADOPTED.

I proceed now to supplement this account of the prevalence of plague in 1875–76, with a description of the various measures which were adopted by the Ottoman and other Governments for the purpose of limiting the diffusion of the malady. In detailing these measures reference will be made almost solely to those used in 1876. Substantially the same measures were put in force in 1874 and 1875.

(a) In Mesopotamia.

At the close of the prevalence of plague in Mesopotamia in 1875 (July), the General Board of Health, Constantinople, proposed to name a permanent Medical Commission for the examination of the districts which had been infected by the disease, and for taking precautionary measures in anticipation of its reappearance. This Commission does not appear to have been formed; and, as already related, notwithstanding the reported occurrence of several cases of "a bubonic malady," at the end of November or beginning of December 1875, in the district of Azizie on the Tigris, no measures seem to have been taken by the sanitary officials in Mesopotamia to ascertain the actual nature of the malady, or, assuming it to have been plague, the extent of its prevalence in the districts bordering the Lower Euphrates. It was not until 20th February that the reappearance of plague was reported to the Board of Health, Constantinople, by telegram from Bagdad; the report also stating that sanitary cordons had been established at Tekrid and Kefri, covering the routes northwards along the Tigris towards Mosul, and north-eastwards into Kurdistan; and that the authorities at Basra had been warned of the danger.

Now at this time, as was ascertained by Mr. Colvill, plague had been active in the district adjoining Hillah, and probably higher up the Euphrates, for a period of three months, and had been continuously present in the town of Hillah since the 1st January. The disease was also most probably present in Kut-el-Amarah, on the Tigris, about the 20th February, and it is little likely to have been absent from Bagdad itself at this time, although not recognised in that city until the second week of March. The disease escaped attention during the period of recommencing activity, when very probably it is most apt to be disseminated, and when most certainly measures can alone be taken with any reasonable chance of arresting its further progress. This want of early knowledge of the beginning of the year's outbreak depended much upon the circumstances under which the outbreak occurred, namely, among communities and tribes which have little and but incidental communication with the greater centres of population, where sanitary officials are stationed; but it also depended upon concealment of the facts by the people. "The aversion of the people," writes Mr. Colvill (1st March 1876), "not only to discuss, but even to mention or "acknowledge the presence of the disease, is extraordinary; and, to "say the least of it, the reticence of all the Government officials "prevents not only a general knowledge of the development of the "disease, but plainly shows how on former occasions nothing at all "was heard of plague till it burst forth carrying off its thousands and "tens of thousands." It would seem, however, from observations in subsequent despatches of Mr. Colvill, that the aversion to disclose the existence of plague among the infected communities is one of the necessary and most unfortunate results of the vexatious restrictions to which they are apt to be subjected with the view of arresting the spread of the disease.

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A despatch from Pera, dated the 8th March, announced the formation of a Commission at Bagdad, consisting of Dr. Paduan, Mustapha Effendi, Dr. Adler, and Dr. Mehemed Ali, to whom were joined Dr. Charles Millingen, of Constantinople, and Dr. Arnaud, then the Ottoman sanitary agent at Jeddah, who had been directed by the General Board of Health to proceed to Bagdad with all despatch. Subsequently Mr. Colvill was added to the Commission as an honorary member. This Commission was appointed to organise the necessary precautionary measures against plague. Soon after (Despatch, Constantinople, 15th March), the Board of Health, dissatisfied with the lax manner in which the measures recommended by the sanitary officials in Mesopotamia were being carried out, sent stringent instructions to the authorities there :—

(*a*.) To empty, wash, and disinfect every house attacked by plague, removing the inhabitants into isolated quarters away from the rest of the population :

(*b*.) To burn infected huts wherever practicable :

(*c*.) To establish cordons at—

(1.) Kifl, for preventing the conveyance of dead bodies from Hillah to Nedjef :

(2.) Kefri, for stopping travellers by that route to Kurdistan, and subjecting them to quarantine :

(3.) Tekrid, on the Tigris, for the same object, as to travellers going to Mosul :

(4.) Biredjek, Deir, Abu Kemal, Abu Maria, and Tadmor on the Euphrates and desert routes to Syria, for a like purpose.*

(*b*) In Ottoman and Egyptian ports.

In addition to these local measures, a quarantine of fifteen days was declared in Ottoman ports against all arrivals from Basra and Fao (which ports now issued foul bills) ; and the Board of Health for Egypt at the same time directed a quarantine of like duration to be instituted against arrivals in the ports of that country from all the ports in the Persian Gulf and from Makallah.

(*c*) In Bagdad.

About the middle of March (Despatch, 22nd March, Constantinople) two other medical men (Dr. Donea and Dr. Cabiades) were sent from Constantinople to Bagdad to assist in carrying out sanitary measures there, and before the close of the month (Despatch, 29th March 1876, Constantinople) it was reported that fifteen capacious reed huts had been erected outside Bagdad, each for the reception of ten plague patients, and that others would be erected as needed; that stone dwellings were being whitewashed; personal effects exposed to infection, which it was not held desirable to destroy by fire, washed; drains and latrines disinfected by sulphate of iron and charcoal; the public baths closed; military parades stopped, and the reserve troops dismissed and sent home. Further, that quarantine against arrivals from Bagdad had been established at Kurna, at the confluence of the Tigris and Euphrates.†

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* The authorities of Damascus on the news reaching that city of the appearance of plague in Mesopotamia, established a cordon at Domner, the last station in the desert before reaching Damascus, for travellers coming from the infected district.

† In a report addressed to the Surgeon-General of the Indian Medical Department, Bombay, under date 30th March 1876, Mr. Colvill writes : "A temporary "hospital of matting was erected on the outskirts of Bagdad, on the right bank, for "those travellers who may be attacked and have no home; but the day before "yesterday a Turkish official with strange indiscretion ordered a householder into "the hospital. The result has been a general exodus, and yesterday about half "the population on that bank of the river, all Arabs, left for the desert."

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With reference to the isolation of cases, Dr. E. D. Dickson reports (29th March 1876): "All patients found amongst the indigent classes, " or in small ill-ventilated houses, are transferred to the huts, and " there treated by the municipal doctor under the supervision of the " Medical Commission. The service is performed by a superintendent, " an apothecary, a cook, and several attendants. Two surgeons and a " female assistant are especially charged with the surgical treatment of " plague sores and swellings, medicines are supplied gratuitously to all, " and the municipality and police agents lend their services on every " occasion. The reed huts that have been occupied by those affected " by the plague, and the clothing of infected persons, are destroyed " by fire."

On the 12th April the General Board of Health, Constantinople, telegraphed renewed instructions to Bagdad for the isolation and disinfection of infected localities, and the strengthening of sanitary cordons; and added a further instruction that the exportation of rags of all sorts from Mesopotamia should be prohibited.

Mr. Colvill states (18th April 1876) that these later instructions required the Governor-General "to cut off communication between all " towns and villages, and also between the portions of Bagdad on the " right and left bank of the Tigris, except for officials and persons of " high degree." The same instructions, he also states, directed the Inspector of the Sanitary Department "to fumigate and blockade all " houses in which plague may appear by placing sentries at the door." Orders were, moreover, given by the Grand Vizier for the evacuation of the prisons, and the removal of the troops in garrison from the barracks; also for encamping the prisoners outside the city in tents, the prisons and the barracks to be then cleansed and disinfected. The General Board of Health further directed a medical officer (Dr. Malezian) to proceed to Diarbekir, and keep watch for any indications of plague there or at Mosul. Instructions were, in addition, given that the exportation of wool from the infected district should not be interfered with, and no processes for its disinfection (from their futility) enforced, but that each cargo should be accompanied with a certificate as to its source.

These several instructions, it will be observed, were issued after the activity of plague had become fully declared, before any certain knowledge existed of the extent of its dissemination, and, so far as they affected the healthy, tended to frustrate those instructions which related to the sick. For the restraints which the instructions imposed upon the healthy supplied numerous motives for concealing sickness, and so rendering inoperative the measures which would alone tend certainly to arrest the progress of the disease, namely, the early removal of the sick of the poorer classes, where practicable, from their dwellings, and their isolation in abundantly ventilated huts, or other buildings set apart for the purpose; or (this measure failing), the securing to the sick, as far as practicable, facilities of ventilation and freedom from crowding in their own dwellings.

Observations of H.M. Consul-General, Bagdad and of Surgeon-Major Colvill, on the measures adopted in Mesopotamia.

The observations of the Consul-General at Bagdad, Colonel Nixon, and of Mr. Colvill, on the operation of the different measures of quarantine referred to, as contained in their despatches from time to time, furnish a most instructive commentary on the directions of the Ottoman General Board of Health, and I quote them in order of date:—

February 22, 1876.—Colonel Nixon observes:—"I am not in a " position to state that there is any necessity for the measure (viz., the " establishment of sanitary cordons at Tekrid and Kifri), but it is apparent " that any cordon established by the Quarantine Department will be

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"quite useless as a precaution against contagion, as the people will evade it as they did last year, and it will have the effect of damaging trade without stopping the spread of the disease."

March 1, 1876.—Mr. Colvill observes:—"I have on previous occasions reported, and the same holds good now, that not only is quarantine as conducted in this province useless, but by collecting together numerous masses without any sanitary care, it tends to spread the disease it is established to check."

March 16, 1876.—Mr. Colvill:—"I called (the Governor-General's) particular attention to the necessity of avoiding the establishment of quarantine, because quarantine, as I know it, in this province is simply a collection of unwashed masses, without any sanitary care; and the result of establishing quarantine at different points round Bagdad will only be cutting off the work of the labourer and raising the price of provisions, while nothing could be devised better than this for the development of plague."

April 18, 1876.—Mr. Colvill, with reference to the before-quoted instructions of the General Board of Health of Constantinople:—"The result of this order, as soon as it is known, will of course be to diminish the returns (of cases) very considerably, for no family will desire to have its house blockaded, and should there be sickness or even death, it will certainly be concealed from observation. It is unnecessary to remark on the worthlessness, however grand it may appear on paper, of the order cutting off communication between towns and villages, while in a corrupt country like this the execution of that order is left in the hands of a soldiery who are in arrears of pay for the last fourteen months, having, at the same time, the outlet that 'officials and persons of high degree' are to pass. I have over and over again remarked not only on the utter worthlessness of quarantine, but also on the harm it actually does. Any quarantine the Turks attempt here will only fan the flame and tend to develop the plague, which undoubtedly will spread over all Asiatic Turkey."

April 18, 1876.—Mr. Colvill observes:—"Bloodshed being threatened, the magistrates of the district in which the infected houses were closed resigned, and the Governor-General has expressed his inability to carry out the blockade measure. I heartily agree with him, for not only would there probably be a rising of the people, but from the formation of the houses the inhabitants can pass from roof to roof as easily as cats."

April 26, 1876.—Mr. Colvill:—"The Shiah Mahommedans not being able to carry their dead to their shrines (Nedjef, Kerbella, Imam Moosa) are burying inside their houses, and never report the cases. This will be a danger when the restrictions are removed, and these bodies are exhumed. . . . . I mentioned also that communication was cut off between the two portions of the city divided by the Tigris, unless for officials and persons of high degree; but every evening 20 or 30 round boats, called kubas, carrying about a dozen people, cross the river under my window after dark. Much to my disgust fumigation was attempted in the houses, not with the intention of doing any good, for in no one instance was it done in the least degree effectually, but confessedly simply to satisfy the demands of the Sanitary Commission at Constantinople. The result, of course, was to produce irritation and cause resistance, and to prevent the returns being anything like complete. . . . . I cannot help thinking that there is now quite as much danger from a rising in the city as

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“ from the plague itself, for the lower orders are irritable and discon-
“ tented, while the wealthier have either left or are on the point of
“ leaving.”

May 10, 1876.—Mr. Colvill :—“ The newspapers from Constantinople
“ informed me that a severe quarantine has been established at Kurna,
“ and since my last letter I visited that place. The quarantine station
“ is on the left bank of the Tigris, above and within sight of the village
“ of Kurna. I found there 53 boats of from 20 to 40 tons, chiefly laden
“ with Turkish Government grain, and four steamers, extending along
“ the bank of the river for a little more than a mile and a half. Immediately
“ on the margin of the river was a narrow swamp with decayed
“ vegetation, and beyond that rice fields. I inquired about travellers
“ and wool, but I found that there were only about a dozen travellers
“ and no wool whatever, while I know that wool is and has been flowing
“ into Busreh (Basra) abundantly. The explanation given as to the
“ paucity of travellers was, that on the Tigris they all landed at Amarah,
“ and passed by Habreiza either to Busreh or Mohammera (Mohamrah);
“ while on the Euphrates they simply diverged through the marshes
“ before entering Kurna, and found their way into Busreh by many
“ roads.

“ There is no attempt made to separate the boats, and the crews
“ intermingle freely together. It may be judged from this that the
“ severe quarantine at Kurna is a simple absurdity, but I notice the
“ name quarantine prevents travellers who have not urgent business from
“ leaving Bagdad.

“ . . . . In previous letters I reported the risk of
“ disturbances here from the irritation caused by the various measures
“ adopted. Since I last wrote there has been a rising in that portion of
“ Bagdad on the right bank. The people began first by protesting
“ against being confined by the ‘ Cordon Sanitaire,’ and being cut off
“ from the left bank where their work chiefly lies; but the exciting
“ cause was the Sunis being permitted to bury in the fashionable
“ burying-ground of Sheik Maroof, while the Shiahs were prevented
“ from using their graveyards at Kaizmani (Imam Moosa), Kerbella,
“ and Nedjef. The Shiahs attacked the Sunis, and a fight occurred
“ which required a regiment of Turkish infantry to subdue it. About
“ 15 people, I believe, were severely wounded. You will remark
“ that I have all along protested against attempting ineffectual measures
“ which simply produce irritation and no good. Now, however, the
“ Local Government and the Sanitary Commission will reap the fruit of
“ their labours, for the people are fast beginning to feel their power,
“ and the immediate result of this disturbance has been to replace the
“ bridge across the river, to open the roads, and allow free communication,
“ the only restrictions being the quarantines established on the
“ border of the Province.”*

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* Mr. Colvill, in a report to Colonel Nixon, dated 3rd August 1876, gives the following illustration, from personal experience, of river quarantine at Bagdad, in respect to plague, in 1874 :—

“ One would have thought that if any internal quarantine could be strictly kept it
“ would be with passengers on board a river steamer. Such, however, was not the case,
“ for when I arrived (at Bagdad) in quarantine in one river steamer another was there
“ before me, and many of the passengers were enjoying themselves in Bagdad. On board
“ of my steamer were many Jewesses returning from a pilgrimage to the tomb of
“ Ezra. A doleful few told me that while during the first evening one or two poor
“ Jewesses came out from Bagdad to be exchanged for their wealthier co-religionists
“ on board, and required 5*s*. for their trouble ; now they wanted 1*l*., or, to be more
“ correct, a Turkish *lira*. All Jewesses, rich and poor, are wrapped up in sheets
“ dyed with indigo, and it is impossible to recognise them. I saw a servant of mine

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These observations of Mr. Colvill and the observations of Colonel Nixon, also quoted, upon the quality of the measures of quarantine against plague established by the Ottoman Government, prove that these measures afforded no security against the extension of the disease, while they directly aggravated the conditions which foster its prevalence. It must be mentioned, however, that the Ottoman General Board of Health, at the date of Mr. Colvill's despatch, from which the extracts last quoted are taken, still reposed faith in the efficaciousness of the measures, the operation of which he describes.

In answer to questions put during a meeting of the Board early in May by the Austro-Hungarian Delegate, on behalf of his Government, Dr. Bartoletti, as Chairman, replied (according to a despatch from Dr. Dickson, of Constantinople, dated 10th of May 1876), as follows:—

"Plague had not extended beyond Mesopotamia; the cordons at " Tekrid, on the Tigris route, and Salahié, on the Euphrates route, had " been strengthened, and appeared to bar effectually its transmission " into Kurdistan and Syria. There was no apprehension of its being " conveyed by sea owing to the restrictive measures enforced at Kurna, " and the quarantine applied to arrivals from every part of the Persian " Gulf."

It is now known (though of course not then known to Dr. Bartoletti) that when he expressed this opinion, plague, carried, as it is believed, along a route free from any interruption at the frontier by quarantine restrictions, had passed the Mesopotamian border into Khuzistan, South-Western Persia, and that a serious outbreak in Shuster was at the time declining.*

With reference to Colonel Nixon's and Mr. Colvill's observations on the effects of the quarantine measures adopted by the Ottoman authorities in damaging trade, interrupting the work of the labourer, and raising the price of provisions, it may be well to remark that to the present time plague in Mesopotamia has chiefly affected the poorer classes, among whom it would seem as if the margin between a sufficiency of food and scanty food were a very narrow one. An exceptional inundation, or a passing interruption of the trade of the district, appears at once to reduce a large proportion of these poorer people to a state of semi-starvation. It is true that during the years 1873 and 1874 there appears to have been abundance of grain and dates, the staple food of the poorer classes; but at the best the poor seem to subsist on an impoverished diet, and to live under conditions of domestic filth and personal squalor, which are aggravated in the marsh villages, among which plague first originated, to a pitch wholly indescribable. The recent outbreaks of plague in 1874 in Bengazi (Tripoli), and in the Assyr district (Western Arabia), concurred with famine; in Persian Kurdistan (1871) with a state of extreme impoverishment which augmented the evils arising from the unutterable filth among which the communities first attacked with the disease lived.

None of the Foreign Office despatches which have been communicated to this Department relative to the progress of plague in

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" bearing on his shoulders a mountain of dirty clothes, in broad daylight, which I had " been wearing while searching for plague on the Euphrates. No one cared, for, on " my remonstrating, my head servant told me that he had arranged with the Guardian. " I ordered the clothes back to the ship, but when I got into Bagdad I found them " washed and ironed ready for use."

* Persian pilgrims returning from Nedjef and Kerbella, also from Mecca, eluded the quarantine stations established on the frontier, by travelling, when it served their purpose, along a route by way of Kut-el-Amarah and Hawiza, which was not guarded by a quarantine station until, apparently, some two months after the appearance of plague in the district adjacent to Shuster.

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Mesopotamia, contain any information as to the extent to which isolation of plague cases had been carried out in Bagdad and elsewhere, and the huts erected for the purpose brought into use.

Towards the close of June, when the outbreak was rapidly declining and had already ceased, the Commission in Bagdad reported to the General Board of Health, Constantinople, (Despatch of Dr. Dickson, 4th July 1876,) "that the moment had arrived to take steps to prevent, " if possible, the recurrence of the malady in those parts ;* and it " recommended the adoption of a plan similar to that suggested by " Mr. Colvill." The plan here referred to is, no doubt, that stated in Mr. Colvill's report of 5th June, 1875 (of which the descriptive portion was included in a note appended to my previous Memorandum). This plan is as follows :—

" I should suggest," he writes, "that during the summer all villages " and groups of huts of the fourth class, such as Um Nejeris and Fowar, " (Fawwar) be destroyed. The proposition is not so formidable when we " consider that, on an average, each of these huts costs less than " 3 rupees. Wood, it is true, is scarce, but where there are beams they " might be smoked and scorched, and the whole of the villages might " be carried and rebuilt with little inconvenience to the inhabitants, " and much benefit to them, a few hundred yards from their present " situation, while compensation might be made out of the overflowing " coffers of the International Sanitary Commission at Constantinople."

The fourth class of villages referred to in the above extract are thus described: " In this class (the only class which has been affected with " plague, according to Mr. Colvill), the villages or groups of huts are " permanent. They are on ground which is a foot or two lower than " the surface of the water in spring, and the ground is so saturated " with water that the refuse of the village is neither absorbed nor can " it be evaporated, for it acquires fresh moisture from the ground, and " this refuse acquires the form of a bluish black oily fluid, which " surrounds the huts and covers the paths, and stains the walls two feet " from the ground, and, in fact, the village is in such a state of filth " that it requires to be seen to be believed."

Subsequently the Bagdad Commission (24th July 1876) informed the Ottoman General Board of Health that the expense of destroying and displacing the reed-built villages would not be great ; and it suggested that this measure should be applied first to Kefl and Kufa. The Commission, moreover, recommended that medical officers should be stationed in the various towns which are to be purified, in order to carry out such measures as might be needed there.

These recommendations were approved by the General Board of Health and authorised by the Porte, but it was found impracticable to carry them into effect, in consequence of the diminished income of the Board, occasioned, it is stated, by the stagnation of trade caused by the political complications then existing, to the stoppage of the pilgrim traffic in Mesopotamia owing to the prevalence of plague there, and to other causes.

To complete this relation, it is necessary to state briefly the precautionary measures taken in Persia, in the Persian Gulf, in India, and by the Russian Government in the Black Sea.

(d) In the Persian Gulf.

In March 1876, on the news of the re-appearance of plague in Mesopotamia reaching Teheran, a Board of Health was formed there,

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* In a telegram dated 21st May 1876, Consul-General Nixon states that, with a view of preventing the recurrence of plague, the Pasha had begun draining the marshes in the vicinity of Bagdad.

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consisting of the Minister of Public Instruction (President), the Director of the College, Dr. Tholozan, Physician to the Shah, five Persian medical officers, Sir J. Dickson, Physician to the British Legation, Dr. Barker, Medical Officer of the Telegraphic Department, Dr. Cominsky, Physician to the Russian Legation, and Dr. Castaldi, Ottoman Sanitary Delegate in Persia. This Board directed—

(*a.*) The interruption of communication between Persia and Mesopotamia, and the establishment of a fifteen days' quarantine on the principal lines of intercourse;

(*b.*) The establishment of a sanitary cordon (as part of the above scheme) at Kari Shireen on the frontier, where it is traversed by the principal route from Bagdad;

(*c.*) The repulsion from the Persian ports in the Gulf of all arrivals from Basra and Fao until after the performance of a fifteen days' quarantine at the Island of Khizr,* opposite to Fao (where the Ottoman quarantine station at the mouth of the Shat-el-Arab is established): men-of-war, having on board medical officers, to be exempt from this regulation.

Immediately on the order as to quarantine at Kari Shireen, on the frontier, reaching the officials there, it was converted into a means of extorting money (Despatch of Sir J. Dickson, 9th April 1876), for not only were arrivals from Bagdad put into quarantine, but all departures from Persia to Bagdad were equally placed under restraint.

With respect to quarantine in the Gulf, it does not appear that any proper provision for performing quarantine exists on the Persian littoral; and such provision as was made had to be extemporised. Medical officers were appointed to inspect vessels and supervise quarantine; and Hajji Jabbar Khan, the Governor of Mohamrah, hired two small vessels, which were stationed at the Island of Khizr for quarantine purposes.

Before the proposed quarantine could be carried out, it was necessary to obtain the assistance of Great Britain; for Persia has no armed force afloat by which obedience to her quarantine regulations could be enforced. The responsibility was, in fact, thrown upon England of enabling Persia to protect her littoral in the Gulf from plague; and an appeal was made to the Indian Government to give the required assistance. This assistance was given (see telegram from the Viceroy, dated Simla, 22nd June, 1876).

While the foregoing measures were under discussion by the Board of Health in Teheran, the British Resident at Bushire had not been inactive in reference to plague. Information of the re-appearance of the disease on the Euphrates was communicated to him by Colonel Nixon, in a telegram on the 2nd of March 1876. He at once took measures for warning the local Persian authorities, the Representatives of other foreign nations in Bushire, the British Agents on both sides of the Gulf, and the merchants trading in the Gulf; and the Residency Surgeon (Dr. R. M. Wall) offered the following suggestions, which were adopted by the local authorities, for protecting the port:—

(1.) That all vessels from Basra be inspected.

(2.) That quarantine upon all passengers (from Basra) to Bushire be enforced.

(3.) That healthy passengers be separated from the infected ones.

In carrying out these suggestions, it was proposed that native craft should be quarantined for five days, after the lapse of which period they would undergo a second inspection, and, should no suspicious cases be discovered on board, would then be given free pratique. Should suspicious cases occur, these were to be removed to hulks moored apart, and prepared to receive them, and a longer period of quarantine was to be enforced on the crews and passengers of vessels from which sick persons were removed.

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* The locality selected here was found unhealthy, and the quarantine station appears to have been afterwards removed to the mouth of the Karun river, in the Shat-el-Arab.

The Persian authorities undertook to take charge of their own subjects, and it was proposed that owners of vessels under British protection should be held responsible for expenses in carrying out such measures as might be considered necessary for the isolation and care of their passengers and crews. A circular memorandum was addressed by the British Resident to all merchants likely to have steamers consigned to them, calling on them to furnish information of the expected periods of arrival of such vessels in view of facilitating the execution of the precautionary measures that were being taken.

The Residency Surgeon appears to have undertaken the inspection of ships arriving off Bushire, and the Residency Apothecary the inspection of native craft. The work of inspection had to be carried on by the aid of an open boat, four miles from the shore, where the anchorage is situated. In rough weather this work was very laborious, and occasionally the inspecting officer was not able to reach the vessel in time to examine all the passengers. "This (was) especially the case" (writes the Residency Surgeon, 28th March 1876,) "with Hajjis, who will not "obey the orders of the captains, and cannot be restrained from getting "into native boats alongside; and it is from Hajji ships in particular "that the danger of importation of disease arises." To meet this difficulty, the Residency Surgeon suggested that all vessels from infected ports should remain in the outer roads till he had inspected them; and pointed out that as the distance from the shore is 8 miles, a steam-launch would, in that case, be necessary to enable him to get to them.

It is to be presumed that the local arrangements at Bushire as to ships from infected ports would be superseded by the instruction as to the repulsion of such ships issued by the Board of Health at Teheran, if the latter were put in force. The papers, however, give no information on this subject.

(e) In India.

The Indian Government instituted (June 1876) a fifteen days' quarantine, including the days of voyage, against infected ports in the Persian Gulf, at Karachi, Bombay, and Aden; not, indeed, it would appear, from any faith in the measure as protective of India, but to prevent all ships sailing from the ports named to the Red Sea being subjected (as threatened by Egypt) to a like period of quarantine in Egyptian ports.

(f) In Russian ports.

In the course of May 1876, the Russian Government issued an Order requiring that the bill of health of all vessels arriving at Russian ports from the southern ports of the Black Sea should be countersigned by a Russian Consul stationed on that coast. (Despatch, Constantinople, 24th May.)

(g) In Mesopotamia, 1877.

With reference to the measures adopted in Mesopotamia since the re-appearance of plague there at the close of the past (1876) and beginning of the present year, the Ottoman General Board of Health determined on the 4th April, 1877, that "it would abstain from the use of any restrictive "measures applied within or around Bagdad, and that it would limit "the efforts of its agents there to assisting and isolating as far as "possible those smitten by the malady, removing the occupants away "from the apartments where they were taken ill, so as to cleanse and

" disinfect them. In order, however, to protect the adjoining provinces, " quarantine measures, assisted by a military force, would be established " at the same stations where they were carried out last year " (Despatch, Dr. E. D. Dickson, 4th April 1877).

With regard to Bagdad, on the occurrence of suspected cases of plague in the city in February, a Sanitary Commission was appointed " for the purpose of making house-to-house visits, cleansing houses and " streets, disinfecting latrines, and filling up all the stagnant pools in " the town. When a house was attacked by the malady, its inmates were " removed from it into huts outside the city, and the sick separated " from the healthy." These measures, it would appear, however, so far as they affected sick persons and dwelling-houses, gave rise to dissatisfaction among the Mahommedan population. Complaint was made to the authorities of the great inconvenience caused by their execution, and a request was preferred that the old system of surrounding the infected houses (which the previous year had helped to provoke serious rioting) might be reverted to in lieu of the above-mentioned mode of dealing with them. The complainants, moreover, in addition, declared their aversion to all sanitary regulations, as they believed them to be contrary to the principles of their faith (Despatch, Dr. E. D. Dickson, 15th March 1877).

June 1877.

NOTE.

A German physician, Dr. Bernhard Beck, resident in Bagdad, in a letter dated the 21st March 1876, of which a translation has been forwarded by Consul-General Nixon,* questioned the accuracy of diagnosis of the disease then prevalent in Bagdad and the adjacent country, as plague. He wrote of the disease as " a new disease," hitherto unobserved, which, " with the exception of swelling of the glands," resembled very closely the malarious fevers (intermittent and pernicious) of the country; and he proposed to name the disease " bubonic fever," or " pestine or pseudo-plague," and held that it stood " in the same relation to plague as cholerine to cholera."

In a communication, moreover, dated the 31st March 1876, and published in the *Wiener Medizinische Wohchenschrift*, under the signature B. B. (Nos. 20, 21, 23, 1876), Dr. Beck, after having seen 100 cases, wrote; " I do not hesitate to say that we have here to deal with a " malarious fever epidemic, somewhat of a pernicious intermittent and " remittent type, and I am, therefore, of opinion that we have not to " do with the actual plague. As this fever is almost always accompanied " by swelling of the glands, that appears to be the reason why it has " been called plague." In this communication Dr. Beck proposed to name the disease " febris intermittens bubonica."

The following is Dr. Beck's description of the disease, given in his letter of the 21st March :—

" On the first day rigor; on the next, vomiting of a yellowish-green " bilious liquid, and appearance of adenitis, chiefly axillary, inguinal, " and crural; the tongue moist, white, velvety; face little altered; " pulse 100 to 140; temperature 39° to 41·5° (Centigrade); buboes " hard, painful, up to size of fist. In severe cases insensibility, coma,

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* This letter appears to have been addressed to one of the Vienna Medical journals, but I have not been able to discover the particular journal in which it appears.

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" somnolence, delirium, dry tongue, livid face, petechiæ on extremities,
" albuminous urine. As regards contagiousness I possess no sufficient
" proofs. After a laxative (patients are generally constipated), and
" after the action of large doses of quinine, I observed in most cases
" a remarkable improvement." Subsequently Dr. Beck stated, that
" large doses of quinine were very effectual in the pernicious marsh
" fever, the pretended 'plague.'"

From no other source has information reached this Department of the successful treatment of the bubonic malady by quinine. It will be observed that Dr. Beck, as Dr. Naranzi in 1867, (see footnote in my previous Memorandum, Report of Medical Officer, New Series, No. VII. p. 89,) while doubting that this malady is "plague," believes it to be a new form of malarial affection. Dr. Naranzi proposed to designate the disease "non-contagious plague-like typhus (*typhus loimoïde non-contagieux*)."

No. 8.

OFFICIAL MEMORANDA ISSUED DURING THE YEAR 1876.

A.

INSTRUCTIONS for ANNUAL REPORTS of MEDICAL OFFICERS of HEALTH.

Instructions for Annual Reports of Medical Officers of Health.

Every medical officer of health appointed under the Order of the Local Government Board dated the 11th November 1872 is required to make an annual report with regard to each sanitary district, or division of a district, which is under his superintendence. This report is to be for the year ending the 31st of December, or, if the officer at that date has not been in office for a whole year, then for so much of the year as has elapsed since his appointment. The report is to be made to the sanitary authority, and a copy of it is to be sent by the medical officer of health to the Local Government Board. It should be made as soon as practicable after the expiration of the year to which it relates. The medical officer of health ought not, in general, to have any difficulty in doing this within a month or six weeks, but if from any special circumstances the report cannot be completed within six weeks, it should be understood that the delay must not be indefinite, and that the report, complete or incomplete, should be in the hands of the sanitary authority within, at most, three months from the end of the year. The Board's copy of the report should be forwarded to them when the original is sent to the sanitary authority, except where the report is likely to be printed by order of the authority. In such cases the Board need only be supplied with a printed copy. But in all cases in which the report cannot be sent to the Board within six weeks from the end of the year, they should be informed by the medical officer of health as to the reason for the delay.

Article 14 of section 4 of the Board's order (a copy of which section is printed below) provides that the annual report is to contain information as to the sickness and deaths that have occurred during the year; the measures taken in order to prevent the spread of disease; and the proceedings of the medical officer of health. It would be well if the report, so far as it relates to the medical officer of health's proceedings, were, in the main, the same in arrangement as the articles which deal with these proceedings; thus stating first what has been done under articles 1–3, which make it the duty of the medical officer of health to inform himself as to the sanitary state of the district, and to make the inquiries and inspections necessary for this purpose; next, the advice which has been given to the sanitary authority under articles 4 and 5; and, lastly, the action he has taken under articles 6-10 in the several matters therein referred to.

As regards the duties imposed under these several articles, each of which will thus be reported on, special attention should be had to the provisions of article 3, which directs systematic inspections of the district to be made by the medical officer of health, apart from the inquiries which under other articles of the order he has to make into particular outbreaks of disease, or into unwholesome conditions to which his attention may have been specially called by complaints or otherwise. The object of these systematic inspections is that the medical officer of health may assure himself that he is well acquainted with all the discoverable circumstances which are likely to affect the public health in his district. How often these inspections require to be made, and how detailed the inquiries should be, must be determined by the particular circumstances of the locality. In some neighbourhoods a house-to-house inspection should as far as possible be made; in others this may not be needful, but every medical officer of health should at certain times set himself to examine into the state of his district, devoting some time to each portion of it, so as to be sure that no part escapes his notice. In making such an inspection the medical officer of health will usually require the assistance of the inspector of nuisances. Of these inspections, of the judgment he has formed thereon as to the sanitary state of his district, and of the advice he has in consequence given to the sanitary authority and the action taken by the authority thereon, the annual report should contain a full account.

As regards the tabular statements of sickness and mortality (forms for which statements are now issued by the Board), only one observation appears to be needful. The district under the superintendence of a medical officer of health will often contain several parts evidently differing in their circumstances, or having very different death rates, either of all registered deaths, or of those from some particular disease or class of diseases. The observation of these differences can scarcely fail to lead to valuable information, and it is in view of those differences that in article 14 the tabular statements are required to be classified according to *localities*, and that provision for such a classification is made in the enclosed forms for returns of deaths. In the absence of any ascertained differences of the above sort, it will still be desirable to classify the deaths of the district according to the part of the district in which they occur, and for this purpose any areas of known population (such as parishes, townships, or wards) may be taken as representing "*localities*" for the purposes of the order. Classification on this basis will be likely to lead to the discovery of real differences when the returns for several years can be compared together.

Having regard to the imperfect character of the information which is obtainable as to non-fatal sickness, such a classification cannot, it seems, be generally attempted in the sickness returns, but in particular cases medical officers of health may be able, and may find it useful, so to classify the pauper sickness of which they receive information.

What has been said above with regard to the information which an annual report should contain must be understood, not as suggesting that the report should be limited to these subjects, or that more detailed or differently arranged tabular statements may not be added, but as indicating the minimum of information which will satisfy the requirements of the Board's order. Many medical officers of health will doubtless, and with great advantage to the administration of their district, give much more detailed information than they are actually required to furnish, and will give especial prominence to the questions to which they have been led by the circumstances of the past year to devote particular attention, or in the investigation of which they may have arrived at valuable conclusions. Any information of this kind will be gladly received by the Local Government Board.

EDWARD C. SEATON, M.D.,
Medical Officer.

Local Government Board,
December 1876.

Extract from the General Order of the Local Government Board of the 11th November 1872 as to Medical Officers of Health.

Section IV.—*Duties.*

The following shall be the duties of a medical officer of health in respect of the sanitary district for which he is appointed; or if he shall be appointed for more than one district, or for a part of a district, then in respect of each of such districts, or of such part:—

(1.) He shall inform himself, as far as practicable, respecting all influences affecting or threatening to affect injuriously the public health within the district.

(2.) He shall inquire into and ascertain by such means as are at his disposal the causes, origin, and distribution of diseases within the district, and ascertain to what extent the same have depended on conditions capable of removal or mitigation.

(3.) He shall by inspection of the district, both systematically at certain periods and at intervals as occasion may require, keep himself informed of the conditions injurious to health existing therein.

(4.) He shall be prepared to advise the sanitary authority on all matters affecting the health of the district, and on all sanitary points involved in the action of the sanitary authority; and, in cases requiring it, he shall certify, for the guidance of the sanitary authority, or of the justices, as to any matter in respect of which the certificate of a medical officer of health or a medical practitioner is required as the basis or in aid of sanitary action.

(5.) He shall advise the sanitary authority on any question relating to health involved in the framing and subsequent working of such byelaws and regulations as they may have power to make.

(6.) On receiving information of the outbreak of any contagious, infectious, or epidemic disease of a dangerous character within the district, he shall visit the spot without delay and inquire into the causes and circumstances of such outbreak, and advise the persons competent to act as to the measures which may appear to him to be required to prevent the extension of the disease, and, so far as he may be lawfully authorised, assist in the execution of the same.

(7.) On receiving information from the inspector of nuisances that his intervention is required in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall, as early as practicable, take such steps authorised by the statutes in that behalf as the circumstances of the case may justify and require.

(8.) In any case in which it may appear to him to be necessary or advisable, or in which he shall be so directed by the sanitary authority, he shall himself inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, or flour, exposed for sale, or deposited for the purpose of sale or of preparation for sale, and intended for the food of man, which is deemed to be diseased, or unsound, or unwholesome, or unfit for the food of man; and if he finds that such animal or article is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall give such directions as may be necessary for causing the same to be seized, taken, and carried away, in order to be dealt with by a Justice according to the provisions of the Statutes applicable to the case.

(9.) He shall perform all the duties imposed upon him by any byelaws and regulations of the sanitary authority, duly confirmed, in respect of any matter affecting the public health, and touching which they are authorised to frame byelaws and regulations.

(10.) He shall inquire into any offensive process of trade carried on within the district, and report on the appropriate means for the prevention of any nuisance or injury to health therefrom.

(11.) He shall attend at the office of the sanitary authority, or at some other appointed place, at such stated times as they may direct.

(12.) He shall from time to time report, in writing to the sanitary authority, his proceedings, and the measures which may require to be adopted for the improvement or protection of the public health in the district. He shall in like manner report with respect to the sickness and mortality within the district, so far as he has been enabled to ascertain the same.

(13.) He shall keep a book or books, to be provided by the sanitary authority, in which he shall make an entry of his visits, and notes of his observations and instructions thereon, and also the date and nature of applications made to him, the date and result of the action taken thereon, and of any action taken on previous reports, and shall produce such book or books, whenever required, to the sanitary authority.

(14.) He shall also prepare an annual report, to be made to the end of December in each year, comprising tabular statements of the sickness and mortality within the district, classified according to diseases, ages, and localities, and a summary of the action taken during the year for preventing the spread of disease. The report shall also contain an account of the proceedings in which he has taken part or advised under the sanitary acts, so far as such proceedings relate to conditions dangerous or injurious to health, and also an account of the supervision exercised by him, or on his advice, for sanitary purposes over places and houses that the sanitary authority has power to regulate, with the nature and results of any proceedings which may have been so required and taken in respect of the same during the year. It shall also record the action taken by him, or on his advice, during the year in regard to offensive trades, bakehouses, and workshops.

(15.) He shall give immediate information to the Local Government Board of any outbreak of dangerous epidemic disease within the district, and shall transmit to the Board, on forms to be provided by them, a Quarterly Return of the sickness and deaths within the district, and also a copy of each annual and of any special report.

(16.) In matters not specifically provided for in this order, he shall observe and execute, so far as the circumstances of the district may require, the instructions of the Local Government Board on the duties of Medical Officers of Health, and all the lawful orders and directions of the sanitary authority applicable to his office.

(17.) Whenever the Diseases Prevention Act of 1855 is in force within the district, he shall observe the directions and regulations issued under that Act by the Local Government Board, so far as the same relate to or concern his office.

(18.) Where more than one Medical Officer of Health shall be appointed by a sanitary authority, such authority, with the approval of the Local Government Board, may either assign to each of the officers a portion of the district, or may distribute the duties of Medical Officer of Health amongst such officers.

B.

Precautions against Scarlatina.

MEMORANDUM on PRECAUTIONS against SCARLATINA (re-edited).

IN every case where scarlatina prevails or threatens to prevail in a district (as, indeed, wherever there is prevalence or threatening of any other epidemic disease), it is of more than common importance that, both by private action and by action of sanitary authorities, everything practicable should be done to ensure freshness of atmosphere and dryness of soil and entire absence of dirt throughout the district, especially in and about houses, and to guard against overcrowding of inhabitants, and to provide that impure water be not drunk. It is of course particularly necessary that such district inspections as are ordered by section 92 of the "Public Health Act, 1875," should be frequently and carefully made by the sanitary authority, and that whatever proceedings are required to procure the abatement of nuisances should be pressed with all practicable despatch.

Sanitary authorities and the public ought also to bear well in mind the contagiousness of scarlatina, and the precautions which that property of the disease renders necessary. Each patient who has scarlatina, whether in a severe or in a slight degree, makes round him an atmosphere in which other persons, if they have not previously had the disease, are very likely to become infected with it. Also, where death occurs, the body of the patient, while unburied, continues a centre of infection. The property of infectiousness probably attaches, more or less, to all matters which pass from the body of the patient during his disease and convalescence, but doubtless it belongs especially to those matters which come from the throat and nose, and from the skin of the patient; the former in foul fluid and solid discharge, and tainting the breath of the patient, the latter particularly represented in the flakes and grains of dry skin which, after the first few days of the disease, begin to shed in the so-called peeling or desquamation. During the illness of the patient infectious particles of these sorts are plentifully diffused in the air round about him, abound in his clothes and bedding, and may attach more or less to all objects in the room. If left to themselves they preserve their infectiousness for very long periods of time; so that, for instance, handkerchiefs which have been used to the patient's mouth and nose, and bedding and clothing which contain the bran-like dust from his skin, and, in various degrees, all things which have been in use in the room, and the dress of persons who have attended there, may, for an indefinite time, be sources of danger. And it is by reason of particles of this kind still hanging about the persons of convalescents, or remaining attached to their clothes, that the contagion of the disease is so persistent.

In taking precautions against the spread of scarlatina, the above points have to be applied, as far as practicable, as follows. Every person who sickens with the disease should at once be removed from among the healthy, and if circumstances do not permit of this being done in his own home, he ought to be treated in hospital. The room to be used as

(A.)

T District of 1876,

Notes on back of sheet.)

Name of	any Hospital or other Public Medical Institution in or near the t or Division, the subjoined columns are to be filled up.				
	In-Patients. Deaths in such institutions among belong to the District or Division.			**Out-Patients.** New cases of Sickness among persons who belong to the District or Division, and are out-patients of Hospitals or patients of Dispensaries.	
	.	Deaths.			
	d 5 Years uwapcds.	Aged under 5 Years.	Aged 5 Years and upwards.	Aged under 5 Years.	Aged 5 Years and upwards.
	11.	12.	13.	14.	15.
Smallpox					
Measles					
Scarlatina					
Diphtheria					
Croup (not “					
Whooping co					
“Continued ” fevers.					
Diarrhœa and					
Cholera					
Rheumatic fe					
Erysipelas					
Pyæmia					
Puerperal fev					
Ague -					
Phthisis					
Bronchitis, and pleuris					
Heart disease					
Injuries					
Diseases not					
Total					

Return f nitary District, or Division of District, for which he acts.

† Sanitary District of

It will be vernment Board; and information given in this Table is
a summary
The Tabl

And in re
Note 1.
2. (*)
3. ber or other
4.
5. ght into the
vate medical
ckness twice

Area and Population of the District or Division to which this Return relates.
Area in acres____________________
Population (1871)____________________

____________________Medical Officer of Health.

41172. X

District of ____________________; classified according to

nd the Births therein during the Year

es, distinguishing Deaths in Persons under Five Years of Age.

tinued Fevers.			Diarrhœa and Dysentery.	Cholera.	Rheumatic Fever.	Erysipelas.	Pyæmia.	Puerperal Fever.	Ague.	Phthisis.	Bronchitis, Pneumonia, and Pleurisy.	Heart Disease.	Injuries.
	Enteric or Typhoid.	Other or Doubtful.											
9.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.

Precautions against Scarlatina.

a sick-room should be divested of every unnecessary thing to which dust or fluff is likely to attach. The room should be thoroughly well ventilated (as by windows and chimney) directly from and into the open air. Persons in attendance on the sick should be persons who already have had the disease. Between the sick-room and the rest of the house there should be no unnecessary intercourse. In the room and on the person of the patient every practicable disinfection should be effected without delay. Some strong disinfectant fluid should always be in use in the room for the various occasions which arise with reference to the discharges and utensils of the sick, and the hands of the attendants. Handkerchiefs and other like articles, as soon as fouled by the patient, should be well scalded with boiling water, or immersed in the disinfectant fluid; and bedding, and other like articles which cannot be treated thus extemporaneously, should be removed, suitably packed, to the place where they can be otherwise disinfected. It is believed that the dispersion of contagious dust from the patient's skin is impeded by keeping his entire body (including limbs and head and face) constantly anointed with oil or other grease, and some practitioners also believe this treatment to be of advantage to the patient himself. When the patient's convalescence is complete, the final disinfection of his surface should be effected by warm baths, with abundant soap, taken on three or four successive days, till no trace of roughness of the skin remains. Not until this has been done, nor without the greatest care that the clothes are clean and free from infection, should the patient, however slight may have been the attack, be allowed to associate with persons susceptible of scarlatina. This caution is of particular importance with regard to schools, and the neglect of it when children return to school, after they have had slight scarlatina, is often a principal source of epidemic infection in districts. Intercourse from houses in which there is scarlatina with other houses should not be more than is necessary; especially children from infected houses (who often may themselves be breeding the disease) should not be allowed to frequent schools and other assemblages of young people. Not unfrequently it may become necessary for the sanitary authority to consider whether temporary closure of schools during the prevalence of the disease should not be recommended. As milk has been found to be in some instances the means of disseminating the infection of scarlatina, special precautions are advisable in the event of the disease appearing in the families of persons dealing in milk.

The bodies of persons dead of scarlatina should be buried with the least possible delay, and should not ever, in the meantime, be kept in rooms inhabited by healthy persons.

When scarlatina has ended in a house, the sick-room should be thoroughly cleansed and disinfected before being again used by healthy people.

Under the "Public Health Act, 1875," penalties are recoverable from persons who wilfully do certain actions which tend to spread dangerous contagious disease, viz., any person who, while suffering from such a disease, enters any public conveyance without notifying to the owner or driver that he is so suffering, or wilfully exposes himself, without proper precautions against spreading the disorder, in any street, public place, or conveyance, or who, being in charge of a child or other person so suffering, so exposes the sufferer; any owner or driver of a public conveyance who does not immediately provide for the disinfection of his conveyance after it has, to his knowledge, conveyed a person so suffering; any person who, without previously disinfecting, gives, lends, sells, transmits, or exposes any bedding, clothing, rags, or other things which have been exposed to infection from such disorders; and, lastly, any

App. No. 8.

OFFICIAL MEMORANDA.

Precautions against Scarlatina.

person who knowingly lets any house, room, or part of a house in which any person suffering from a dangerous contagious disorder has been, without having disinfected the same to the satisfaction of a medical practitioner, to be testified by a certificate.

Under the same Act large powers are given to sanitary authorities for the purpose of preventing the spread of contagious disorders, viz., to cause any infected house or part of a house to be cleansed and disinfected; to provide a proper place, with all necessary apparatus and attendance, for the disinfection of articles (such as clothing or bedding) which have become infected; to cause any articles brought for the purpose to be disinfected free of charge; and to direct the destruction of infected articles, giving compensation for the same. Powers are also given to provide hospitals, either temporary or permanent, and carriages for the conveyance to them of the sick, and to provide places for the reception of dead bodies.

Where a hospital for the reception of the sick has been provided in or near to a district, a justice, on application, may order any person suffering from a dangerous contagious disorder, and being without proper lodging or accommodation, or lodged in a room occupied by more than one family, to be removed to such hospital at the cost of the local authority; and any person so suffering who is lodged in any common lodging house may be removed to such hospital by order of the local authority. Where a mortuary has been provided, the removal to it of dead bodies, at the cost of the local authority, may, in certain cases, also be ordered.

Chemical disinfectants are of two great classes, and hitherto it is not certain which of the two classes acts best. The one class is well represented by *chlorine and certain of its compounds*; the other is well represented by *carbolic acid.* Under the one system, the solution of chloride of lime may be used for minor domestic purposes, and chlorine gas for disinfection of rooms. Under the other system, carbolic acid may be used for minor domestic purposes, and sulphurous acid gases for disinfection of rooms. These systems do not combine well with one another, and in the choice which has to be made between them it will be convenient that the sanitary authority should declare which of the two systems it adopts, and that all private disinfection in each district should follow such lead of the authority. The detail in each case will be advised by the medical attendant. In public disinfection establishments (under section 122 of the Public Health Act, 1875) for the disinfection of wearing apparel, bedding, curtains, and other large household articles, the most convenient process consists in employment of high degrees of heat.

EDWARD C. SEATON, M.D.,
Medical Officer.

Local Government Board,
October 25th, 1876.

C.

MEMORANDA FOR LOCAL ARRANGEMENTS RELATING TO INFECTIOUS DISEASE (re-edited).

I.—*On Hospital Accommodation to be given by Local Authorities.*

Hospital Accommodation.

A LARGE part of the mortality of England is caused by diseases which spread readily by infection from person to person; such as scarlatina, typhus, small-pox. In order to prevent the extension of such diseases in neighbourhoods were they have begun, it is of the utmost importance that, in addition to whatever other sanitary measures may

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be requisite, every practicable endeavour should be made to separate the sick from the healthy. Such separation is comparatively easy, if means to attain it are taken early, while cases of the disease are very few; but any interval of delay allows the cases of sickness to multiply, and perhaps at last to become so numerous that endeavours to issolate them cannot succeed. These considerations are especially important with regard to the poorer classes of the population, whose usually crowded and ill-ventilated dwellings give extreme facilities for infection, and among these classes, the sick generally speaking, cannot be separated from the healthy, except in proportion as they can be removed from home into proper hospital accommodation provided for their reception.

Under the 131st section of the Public Health Act, 1875, every sanitary authority (whether urban or rural) has power to provide "for the use of the inhabitants of their district, hospitals or temporary "places for the reception of the sick." When this provision has been made, any justice may order the removal to such places of any person suffering from any dangerous infectious disease, if he is without proper lodging or accommodation, or lodged in a room occupied by more than one family, or is on board any ship or vessel.

The present memorandum is intended for the assistance of sanitary authorities, who having to secure the isolation that is needed for cases of dangerous infectious disease, but not yet having the requisite hospital accommodation within their districts, desire to provide such accommodation under the powers of section 131 of the Public Health Act, 1875, or otherwise.

A condition of the highest degree of importance for the usefulness of any such accommodation is, that the accommodation shall be ready beforehand. The quantity of accommodation wanted will, of course, be widely different in different cases; but it must always be remembered that when two infectious diseases are prevalent in one place at one time, patients having the one infectious disease cannot properly be in the same ward with patients having the other infectious disease. In kind, the accommodation ought, in all cases, to be as good as the authority can reasonably supply. It is believed, however, that, even under these conditions, the costs of providing hospital accommodation, whether for villages or for towns, needs not ever be proportionately great.

As regards villages, each village ought to have the means of accommodating instantly, or at a few hours' notice, say, four cases of infectious disease in at least two separate rooms, without requiring their removal to a distance. A decent four room or six room cottage, at the disposal of the authority, would answer this purpose; or permanent arrangement might be made beforehand with trustworthy cottageholders, not having children, that they should receive and nurse, in case of need, patients requiring such accommodation; and small adjacent villages (if under the same sanitary authority) might often have such arrangements in common. If, in villages where such provision as this has been made, cases of disease in excess of the accommodation occur, the sick must not be crowded together, but temporary further provision should be made for them. The most rapid and the cheapest way of obtaining this further accommodation, may often be to hire other neighbouring cottages; or, in default of this, tents or huts may be erected upon adjacent ground.

In towns, hospital accommodation for infectious diseases is wanted more constantly, as well as in larger amount, than in villages; and in towns there is greater probability that room will be wanted at the

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Hospital Accommodation.

same time for two or more infectious diseases which ought not to be treated in the same ward. The permanent provision to be made in a town, in order to obtain reasonable security against the spread of infectious diseases, should consist of not less than four rooms, in two separate pairs; each pair to receive the sufferers from one infectious disease, the men and women of course separately. The number of cases for which permanent provision should be made must depend upon various circumstances, chiefly upon the size of the town, and, as no closely limited amount of permanent accommodation can be trusted always to suffice for the requirements of considerable epidemics, foresight must from the first be used, how, in emergency, additional accommodation can be temporarily given, to meet requirements in excess of the permanent provision. Accordingly, for a town of any importance, the hospital provision ought to consist of a permanent building, having around it space enough for the erection of temporary structures, as occasion may require. Considerations of ultimate economy make it wise to have the permanent building equal to somewhat more than the average necessities of the place, so that recourse to temporary extensions may less often be wanted. In small towns, for instance, if a hospital, consisting of four wards and the necessary administrative offices, is to be provided, the original expense of making each ward serve for (say) eight persons, will be far less than double that of making the wards for four. And in any case it is well to make the administrative offices somewhat in excess of the wants of the permanent wards; because thus, at little additional first cost, they will be ready to serve, when occasion comes, for the wants of the temporary extensions.

It is not proposed to discuss in detail, in this memoradum, the principles on which permanent hospitals for infectious diseases should be built; but it may be noted, that in order to the practical success of any such hospital, the following conditions have particularly to be studied:—

Accessibility of situation, so that the sick may not be exhausted by long journeys; wholesomeness of situation; and as far as consists with these conditions, an open uncrowded neighbourhood:

Adequate ward-space for each patient, approaching as nearly as circumstances allow to 2,000 cubic feet, with a floor space of not less than 144 square feet:

Thoroughly good provision for ward ventilation (*i.e.*, for sufficient unceasing entrance of pure air and of exit of ward air), with arrangements also for immediate change of air in the whole ward, when necessary:

Perfect security against the possibility of any foul air (as from privies or sinks) entering any ward:

Means of warming each ward in winter to a temperature of 60° Fahrenheit, and of keeping it cool in summer:

Safe means (safe both for the hospital and for the neighbourhood) for disposing of excremental matters and of slops, and for cleansing and disinfecting infected linen and bedding:

Facilities for obtaining, in the use of the hospital, the very strictest cleanliness of every part.

When the pressure of a particular epidemic requires temporary extension of the accommodation, or when, the provision of a permanent hospital having been neglected, accommodation for cases of infectious disease is suddenly required, huts, or in summer, tents, will sufficiently answer the purpose.

The tents may be either such as the bell tent or hospital marquee of Her Majesty's army, or one of the various forms of tent and marquee used in civil life. Huts may be of wood or iron; and, if the administrative part of the original building have been thoughtfully devised, these temporary erections may be of very simple construction. Both tents and huts need to be carefully arranged and regulated, especially in the following respects.

As to Tents.—It is essential to secure the dryness of the ground upon which they are pitched, by trenching around and between them, so as to carry off all rainfall and prevent the lodgment of moisture. The tents should everywhere be distant at least a diameter and a half from each other. The approaches should be paved or otherwise prepared, to prevent their being trodden into mud in wet weather, and it is especially requisite that abundant proper means be provided for the reception of refuse matters, and that no casting of slops or other refuse upon the ground in the vicinity of the tents be allowed. In the distribution of patients in active stages of disease, not more than one patient should be assigned to a bell tent of the ordinary regulation size, nor more than three such patients to the regulation hospital marquee;* and in other forms of tents the number of patients should be regulated in similar proportions. Tents should always be provided with special ventilating openings. They should have boarded floors, raised sufficiently above the ground so as to allow of air passing freely beneath. From the ready inflammability of the ordinary canvas of which tents are constructed, much care is required in the use of lights in tents; and tents should not be used in states of weather which render artificial warming necessary, if sufficiently rapid provision for the isolation of the sick can otherwise be had. The safest method of warming a hospital marquee is by a flue carried beneath the floor, from a stove placed in an excavation outside the tent to a chimney also beyond the tent wall.

As to Huts.—Dryness of site is, as in the case of tents, of the first importance. Each hut should be trenched round. Its floors should be raised a foot or a foot and a half from the earth, so as to permit the free under passage of air; but care must be taken to prevent the lodgment of moisture or impurities beneath the floor. In some cases a layer of concrete under the hut may be necessary to prevent dampness. A distance not less than three times the wall-height of a hut should intervene between any two huts, and each hut should be so placed as not unnecessarily to interfere with free circulation of air round other huts. In huts, as in permanent buildings for the treatment of infectious diseases, 2,000 cubic feet, with 144 square feet of floor, is the standard of space that should be allowed to each patient. The ventilation of huts, also, is of equal importance with that of permanent hospital buildings. It is best secured by the combination of side-windows with roof-opening, the latter protected from rain, and running the whole length of the ridge of the roof. The side-windows should not be of less size than ordinary house windows; they must freely open top and bottom, and for this purpose had best be sash-windows; they should be placed in similar series on opposite sides of the wards, one window between each pair of beds. The ventilating opening beneath the ridge may have flaps, moveable from within the hut by ropes and pulleys, so that the opening to windward can be closed, if necessary, in high winds.

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* *Regulation Bell Tent.*—Diameter, 14 ft; height, 10 ft.; area of base, 154 square ft.; cubic space, 513 ft.

Regulation Hospital Marquee.—Length, 29 ft.; width, 14 ft.; side walls, 5 ft. 4 in.; height to ridge, 11 ft. 8 in.; area of base, 396 square ft.; cubic capacity, 3,366 ft.

Double-walled wood huts may have additional ventilation by the admission of air between the outer and inner walls, and its passage into the interior of the hut through openings with moveable covers at the top of the inner lining. The roof should be covered with waterproof felt; the edges of the felt fastened down by strips of wood, not directly by nails. The hut should be warmed by open fire-places, fixed in brick stove-stacks, or by open stoves placed in the centre of the floor, the flue being carried through the roof, with all the needful precautions to guard against ignition of the wood-work.

The sewerage and scavenging arrangements both of tents and huts demand very careful consideration. When the tents or huts are placed within the area of a public system of sewerage and water supply, no difficulty will arise; for drains may be laid into the public sewer, and water-closets may easily be adopted. But where no system of sewerage exists, the disposal of excremental matters and other refuse will require special provisions. In regard to excremental-disposal under such circumstances, the best method to adopt is the dry-earth system, or, failing this, a pail system, with careful arrangements for the disinfection and subsequent disposal of the excrementitious matter. All slops and other refuse should be deposited in metal pails, to be removed from the tents and huts at frequent intervals, and should be so disposed of as not to become a nuisance. Too much attention cannot be given to the careful scavenging of tents and huts, and to the proper disposal of the refuse from them; and the servant or servants to whom the duty is assigned (as indeed all service which concerns the cleanliness and wholesomeness of the hospital) should be under very vigilant supervision.

Appended is a plan of a hospital hut for male and female patients, and a section of a double-walled military hospital hut constructed out of ordinary scantling. If no cottage or other building has been adapted permanently for the administrative purposes of the hospital, or can be rendered available for them, the kitchen and other necessary offices (larder, wash-house, bedding and linen stores, additional nurses' accommodation, nurses' closet, dead-house, &c.) are most readily provided by simply constructed huts, set near the huts or tents which contain the sick.

Appended, also, is a diagram illustrating the way in which several separate huts may be arranged so as to provide for the necessities of a considerable epidemic, or for the case of several epidemic diseases prevailing at the same time.

II.—*On Ambulances.*

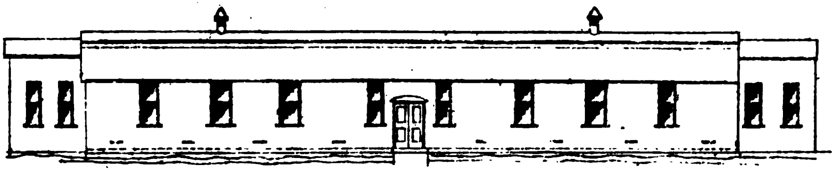
Ambulances.

For the conveyance of patients who are sick with infectious disease, special carriages, which are known by the name of "ambulances," are necessary. Such carriages may be provided by sanitary authorities under sect. 123 of the Public Health Act, 1875. The following points have to be attended to in the provision and use of such carriages :—

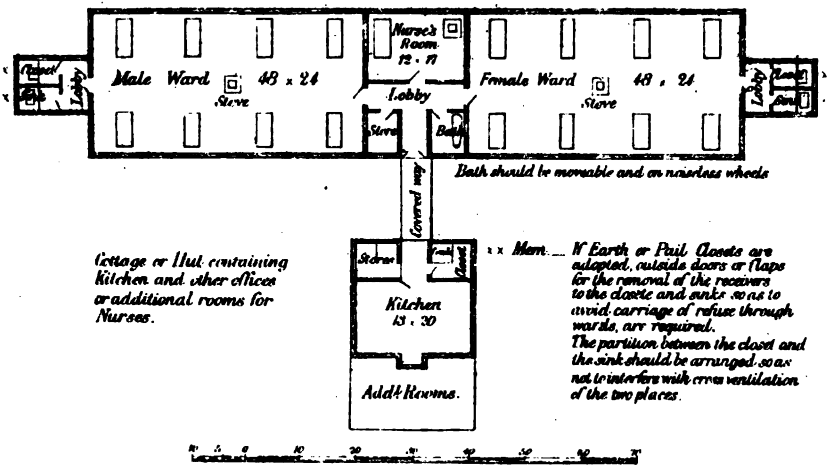
1. If the ambulance be intended only for journeys of not more than a mile, it may be made so as to be carried between two people, or it may be on wheels and to be drawn by hand. If a distance be above a mile, the ambulance should be drawn by a horse. Every ambulance on wheels should have easy carriage-springs.
2. In the construction of an ambulance, special regard should be had to the fact that after each use it has to be cleansed and disinfected. The entire interior, and the bed-frame and bed, should be of materials that can be washed.

PLAN OF A HOSPITAL HUT FOR EIGHT PATIENTS OF EACH SEX HAVING THE SAME INFECTIOUS DISEASE.

Elevation.



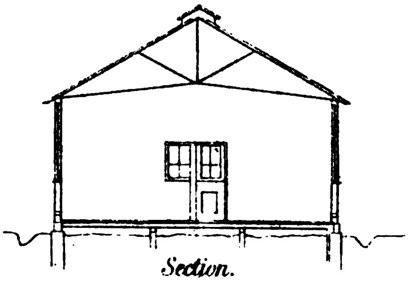
Plan.



Bath should be moveable and on noiseless wheels

Cottage or Hut containing Kitchen and other offices or additional rooms for Nurses.

x x Mem. — If Earth or Pail Closets are adopted, outside doors or flaps for the removal of the receivers to the closets and sinks so as to avoid carriage of refuse through wards, are required. The partition between the closet and the sink should be arranged so as not to interfere with cross ventilation of the two places.



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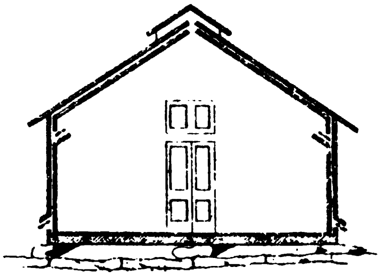


Section of Double Cased Hut.

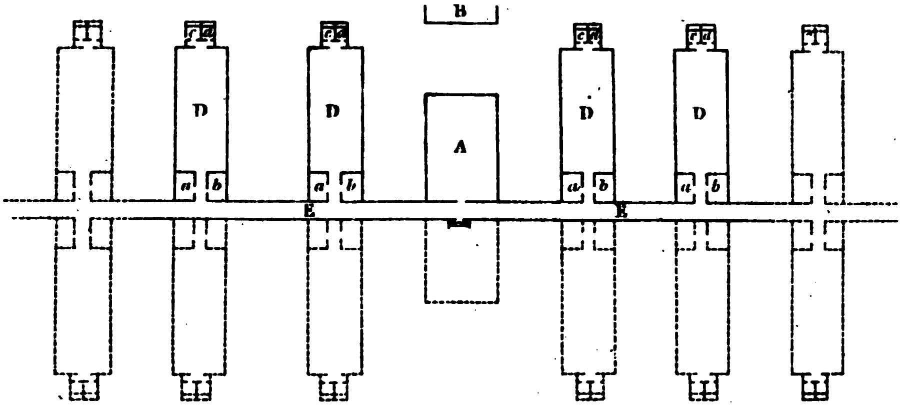
SCALE TO SECTIONS.

Dangerfield Lith. 22 Bedford St. Covent Garden

DIAGRAM ILLUSTRATING ARRANGEMENTS & MODES OF EXTENSION OF HUT-HOSPITALS.

PLAN 1.

The Huts arranged parallel to each other not less than 30 feet distant.

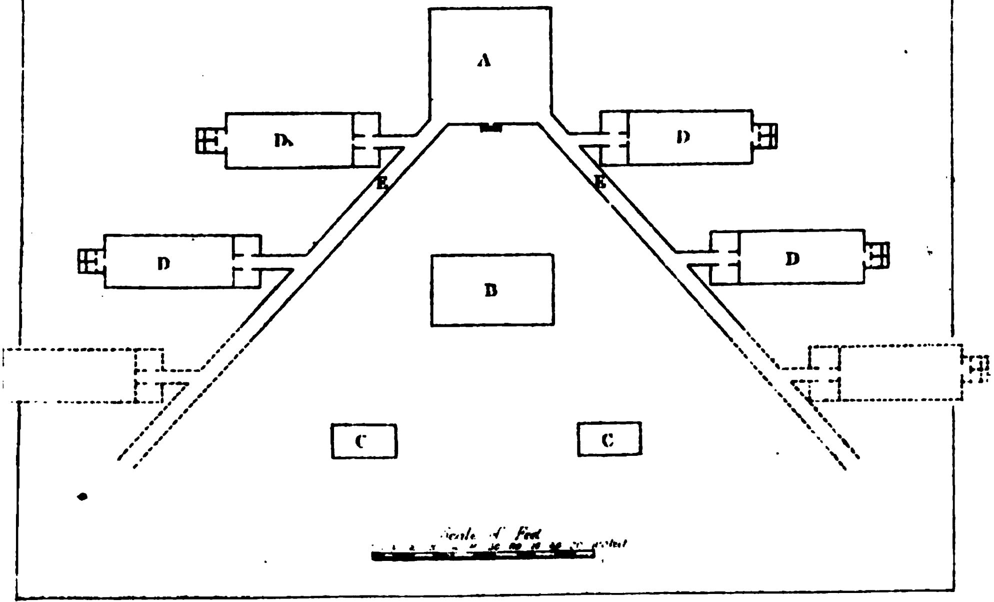


REFERENCE.

A. *Administrative Buildings (Kitchen, Stores, Offices, Nurses Bedrooms, &c.)* B *Laundry, &c.*
C. *Disinfection, Dead House &c.* D. *Huts shown of dimensions for 10 patients each, with Scullery & Bathroom (a.b.) at one end, and closet & sink (c.d.) at other end of each.*
E. *Open Corridors. The dotted lines show direction of further extension.*

PLAN 2.

(Preferable when plenty of ground is available.) The huts arranged in double échelon.



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TILDEN FOUNDATIONS.

Ambulances.

3. The ambulance should be such that the patient can lie full length in it; and the bed-frame and bed should be moveable, so that the patient can be arranged upon the bed before being taken out of his house.
4. With an ambulance there should always be a person specially in charge of the patient; and a horse-ambulance should have a seat for such person inside the carriage.
5. After every use of an ambulance for infectious disease, it should be cleansed and disinfected to the satisfaction of a medical officer.
6. Both in very populous districts, and in districts which are of very wide area, it may often happen that more than one ambulance will be wanted at one time; and, in any district, if more than one infectious disease is prevailing, there will be an evident sanitary advantage in having more than one ambulance for use.

Edward C. Seaton, M.D.,
Medical Officer.

Local Government Board,
December 1876.

D.

Memorandum on Re-Vaccination (re-edited).

Re-vaccination.

By vaccination in infancy, if thoroughly well performed and successful, most people are completely insured, for their whole life-time, against an attack of small-pox; and in the proportionately few cases where the protection is less complete, small-pox, if it be caught, will, in consequence of the vaccination, generally be so mild a disease as not to threaten death or disfigurement. If, however, the vaccination in early life have been but imperfectly performed, or have from any other cause been but imperfectly successful, the protection against small-pox is much less satisfactory; neither lasting so long, nor while it lasts, being nearly so complete as the protection which first-rate vaccination gives. In consequence of the large amount of imperfect vaccination which has till very recent years existed, the population contains very many persons who, though nominally vaccinated and believing themselves to be protected against small-pox, are really liable to infection, and may in some cases contract as severe forms of small-pox as if they had never been vaccinated. Partly because of the existence of this large number of imperfectly vaccinated persons, and partly because also even the best infantine vaccination sometimes in process of time loses more or less of its effect, it is advisable that all persons who have been vaccinated in infancy should, as they approach adult life, undergo re-vaccination. Generally speaking, the best time of life for re-vaccination is about the time when growth is completing itself, say from 15 to 18 years of age; and persons in that period of life ought not to delay their re-vaccination till times when there shall be a special alarm of small-pox: first because they can never tell how soon, or by what chance, they may (even at times when there is little prevalence of that diseaee) be exposed to its infection; and secondly, because of the much more advantageous conditions under which the re-vaccination can be performed when it can be done leisurely, than when it has to be done under the pressure caused by a panic. When, however, small-pox becomes epidemic, not only should all persons above 15 years of age who had hitherto neglected to have themselves re-accinated be very careful to neglect it no longer, but in proportion as there is prevalence of small-pox in any neighbourhood, or as individuals are from personal circumstances likely to meet chances of infection, even the age of 15 should not be waited for, especially not by young persons whose marks of previous vaccination are unsatisfactory. The rule applicable to circumstances of special danger is this; that everyone past childhood on whom revaccination has not before been successfully performed, should without delay be re-vaccinated.

Re-vaccination, once properly and successfully performed, does not appear ever to require repetition. The nurses and other servants of the London Small-Pox Hospital, when they enter the service (unless it be certain that they have already had small-pox), are invariably submitted to vaccination, which in their case generally is Re-vaccination, and is never afterwards repeated; and so perfect is the protection, that though the nurses live in the closest and most constant attendance on small-pox patients, and though also the other servants are in various ways exposed to special chances of infection, the Resident Surgeon of the Hospital, during his 41 years of office there, has never known small-pox affect any one of these nurses or servants.

Legal provisions for re-vaccination are made in the 8th section of the Vaccination Act, 1867, in Section IV. of the Regulations which the Lords of the Council under authority of that Act issued in their Order of February 18th, 1868, and in the 9th section of the Vaccination Act, 1871. Under these provisions, re-vaccination is now performed by all Public Vaccinators at their respective vaccinating stations; and, so far as is not inconsistent with the more imperative claims for primary vaccination, any person coming within the terms of these provisions may, on applying to the public station of the district in which he resides, obtain re-vaccination free of personal cost.

Edward C. Seaton, M.D.,
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Local Government Board,
October 17th, 1876.

Section VIII. of the Vaccination Act, 1867, is as follows:—"The "provisions of the contracts entered into before this Act comes into "operation shall not, after the thirty-first day of December next, apply "to the cases of persons who, having been previously successfully "vaccinated, shall be re-vaccinated; but if the Lords of Her Majesty's "Council shall have issued or shall hereafter issue regulations in "respect of the re-vaccination of persons who may apply to be re-"vaccinated, which such Lords are hereby authorized to do, the "guardians shall pay, in respect of every case of successful re-vaccina"tion performed in conformity with such regulations under such "contracts or under new contracts entered into after the date hereof, "a sum amounting to two-thirds of the fee payable upon each case of "successful primary vaccination."

Section IV. of the Regulations issued by the Lords of the Council in their Order of February 18, 1868, is as follows:—"The performance "of re-vaccination by the Public Vaccinator on persons applying to "him for that purpose shall be limited in each case by the following "conditions—(1) that, so far as the Public Vaccinator can ascertain, "the applicant has attained the age of fifteen years, or if, during any "immediate danger of small-pox, the age of twelve years, and has not "before been successfully re-vaccinated; and (2) that, in the Public "Vaccinator's judgment, the proposed re-vaccination is not for any "sufficient medical reason undesirable; and (3) that the Public

Re-vaccination.

" Vaccinator can afford vaccine lymph for the purpose without in any " degree postponing the claims which are made on him for the per- " formance of primary vaccination in his district."

Section IX. of the Vaccination Act, 1871, is as follows :—" Where " the operation of re-vaccinating any person is performed on the application of such person by the public vaccinator without charge to " such person, the public vaccinator shall deliver to such person a " notice requiring him to attend at the same place on the same day " in the following week, in order that he may be inspected and the " result of the operation ascertained, and stating that in default he will " be liable as in this section mentioned, and the public vaccinator, if " required, shall deliver to the person re-vaccinated a certificate of the " result of the operation of re-vaccination ; and if such person fail " to comply with such notice, or to permit the public vaccinator or his " deputy to ascertain the result of the operation, he shall pay a fee " for such re-vaccination of two shillings and sixpence, which fee " shall be a debt due from him to the guardians of the union or parish " in which such public vaccinator acts, and all such fees shall be paid " to and all expenses of the guardians incurred under this section shall " be paid out of the fund out of which the expenses of the guardians " under the principal Act are paid."

E.

Memorandum of the National Vaccine Establishment on Lymph Supply for Re-Vaccination.

Lymph-Supply for Re-vaccination.

The frequent demands which are made on the National Vaccine Establishment for the supply of lymph for re-vaccination—sometimes for the re-vaccination of large numbers of persons—render it necessary to explain that the supply of lymph for that purpose is not within the objects for which the establishment was instituted, and that the fulfilment of these demands, except to a very moderate extent, is not within its power.

Re-vaccination, in regard of lymph supply, differs unfortunately from primary vaccination, in that it contributes nothing to its own support, but that each case of re-vaccination, while requiring to draw lymph from a case of primary vaccination, will itself furnish no available lymph in return; for, even when good vesicles result from re-vaccination, their lymph cannot properly be used for other vaccinations or re-vaccinations. Thus, no wholesale revaccination is possible which does not have for its basis a large system of primary vaccination, such as, in England, exists only in the hands of the public vaccinators.

At the public vaccination stations a large majority of all the infantine vaccinations of the country are performed in successive weekly groups; the cases of each vaccinating day returning a week afterwards to furnish lymph for the arm-to-arm vaccination of a new group. Each well-frequented station is thus a continuous source of primary lymph-supply, and is able, not only to maintain its own weekly performances of vaccination and re-vaccination, but also to contribute more or less towards the requirements of places where the public stations are too ill-frequented for the maintenance of a continuous supply, and towards the similar requirements of private practitioners. It is from certain of these stations, carefully selected and superintended, that the National Vaccine Establishment receives regular contributions of lymph, preserved dry on ivory points, or liquid in capillary tubes; and it is out of the stock

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thus contributed that the establishment answers day by day the demands which are made on it for lymph: demands, emanating not only from among the many thousand vaccinators, public and private, of the civil population of the United Kingdom, but also from Her Majesty's army and navy in all parts of the world, from the diplomatic and other foreign services, and from the colonies.

The principle on which the National Vaccine Establishment proceeds (and has always proceeded) in its distribution of lymph, whether to public or private vaccinators, is as follows:—It furnishes each applicant with a sufficiency for the performance of a few first vaccinations, and it expects that the recipient, so far as the circumstances of his practice render necessary, will exert himself to vaccinate in series from the beginning which he is thus enabled to make. This principle is acted on in relation to public vaccinators (as especially in country districts) whenever, from local circumstances, the weekly succession of groups of cases has been interrupted; and no other principle can be worked on a large scale in relation to private vaccinators. If re-vaccinations are in question, they, to any considerable extent, cannot be immediately dealt with at the expense of the central depôt. And if the vaccinator, on receiving his packet of preserved lymph, does not use it for starting primary vaccinations, from which afterwards his re-vaccinations could be performed, but, instead of so doing, expends the preserved lymph on some of his claimants for re-vaccination, he must not rely on being able to satisfy other claimants with new supplies from the central depôt.

Where medical practitioners, not being public vaccinators, and not having otherwise in their practice cases for primary vaccination, are called upon to re-vaccinate on a considerable scale (as in hospitals, commercial establishments, schools, and even large households), they would generally find it best to make direct application for assistance to the public vaccinator of the district in which they have to act; with whose assistance they may commonly find it in their power to arrange with the parents of children recently vaccinated at the public station, that some of such children shall at the proper time be taken to places where private re-vaccinations have to be performed, so as to furnish from arm to arm any required quantity of lymph. Generally, too, any private medical practitioner who, from any cause, desires to obtain extraordinary supplies of lymph, will most easily attain his object by applying to the public vaccinator of the district in which he resides And as public vaccinators, appointed under the Vaccination Act, 1867, are of course free to accept payment for any extra-official work which they may be willing to undertake, private practitioners would probably have no difficulty in obtaining, by voluntary agreement, the assistance of some of these officers as collectors of lymph for private re-vaccination.

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